Measurement Studio™

User Manual

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NATIONAL INSTRUMENTS™

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Contents

About This Manual

How To Use this Manual ix
Conventions x

Chapter 1
Introduction to Measurement Studio

Installation Requirements 1-1
Deployment Requirements 1-2
Installation Instructions 1-2
Measurement Studio Package Comparison Chart 1-4
Measurement Studio Resources 1-6

Chapter 2
Measurement Studio .NET Class Libraries

Measurement Studio .NET Class Library Overview 2-1
Analysis 2-2
    Standard Analysis 2-2
    Professional Analysis 2-2
    Enterprise Analysis 2-3
Common 2-12
DataSocket 2-13
NI-488.2 2-13
NI-DAQmx 2-14
NI-VISA 2-15
User Interface 2-15
    Waveform Graph and Scatter Graph Controls 2-16
        Plot Operations 2-17
        Axis Operations 2-18
        Cursor Operations 2-18
        Annotation Operations 2-18
        Additional Operations 2-18
    Digital Waveform Graph Control 2-18
        Plot Operations 2-19
        Additional Operations 2-20
    Complex Graph Control 2-20
        Plot Operations 2-21
        Axis Operations 2-21
        Additional Operations 2-21

Legend Control 2-21
Numeric Controls 2-22
Numeric Edit Control 2-24
Switch and LED Controls 2-25
Property Editor Control 2-26

Chapter 3
Measurement Studio Visual C++ Class Libraries

Measurement Studio Visual C++ Class Library Overview 3-1
ActiveX Controls in Visual C++ 3-2
3D Graph Control 3-2
Plot Operations 3-3
Additional Operations 3-3
Analysis 3-3
Standard Analysis 3-4
Professional Analysis 3-4
Enterprise Analysis 3-4
Common 3-14
DataSocket 3-15
Instrument Drivers 3-15
LabVIEW Real-Time Interface 3-16
Microsoft Excel Interface 3-16
Microsoft Word Interface 3-17
NI-488.2 3-17
NI-DAQmx 3-17
NI-Reports 3-18
NI-VISA 3-18
User Interface 3-19
Button Control 3-20
Graph Control 3-21
Plot Operations 3-21
Axis Operations 3-21
Additional Operations 3-22
Knob Control 3-22
Numeric Edit Control 3-23
Slide Control 3-24
Utility 3-25

Chapter 4
Developing with Measurement Studio

Measurement Studio Menu 4-2
Creating a Measurement Studio Project 4-3
Adding or Removing Measurement Studio Class Libraries 4-4
Walkthrough: Creating a Measurement Studio Application with Windows Forms Controls and Analysis 4-5
Creating a Measurement Studio NI-DAQmx Application 4-13
Creating an NI-DAQmx User Control 4-15
Walkthrough: Creating a Measurement Studio NI-DAQmx Application 4-15
Creating a Measurement Studio NI-488.2 or NI-VISA Application 4-28
Walkthrough: Creating a Measurement Studio Instrument I/O Application 4-30
Selecting a Measurement Studio Parameter Value 4-38
Calling Instrument Drivers from .NET Languages 4-38

Appendix A
Technical Support and Professional Services

Glossary

Index

About This Manual

The *Measurement Studio User Manual* introduces the concepts associated with the Measurement Studio class libraries and development tools. This manual assumes that you have a general working knowledge of Microsoft Visual Studio .NET, including Microsoft Visual Basic .NET, Microsoft Visual C#, or Microsoft Visual C++.

How To Use this Manual

Measurement Studio 8.0 includes two CDs—one with support for Visual Studio .NET 2003 and one with support for Visual Studio 6.0. This manual documents the Visual Studio .NET 2003 CD. For help with Visual Studio 6.0, refer to the *Measurement Studio Support for Visual Studio 6.0 Readme* located on the Measurement Studio for Visual Studio 6.0 CD.

The Measurement Studio User Manual is organized into four chapters. Chapter 1, *Introduction to Measurement Studio*, is an overview of Measurement Studio. This chapter includes installation and distribution requirements, installation instructions, and a list of Measurement Studio resources. Chapter 2, *Measurement Studio .NET Class Libraries*, and Chapter 3, *Measurement Studio Visual C++ Class Libraries*, include information about the .NET class libraries and the Visual C++ class libraries, respectively. Chapter 4, *Developing with Measurement Studio*, includes information on using Measurement Studio tools and walkthrough sections that guide you through step-by-step instructions on how to develop with Measurement Studio features.

Use this manual as a starting point to learn about Measurement Studio. Refer to the *NI Measurement Studio Help* within the Visual Studio .NET environment for function reference and detailed information about the Measurement Studio class libraries, wizards, assistants, and other features.

Conventions

The following conventions appear in this manual:

»	The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.
	This icon denotes a tip, which alerts you to advisory information.
	This icon denotes a note, which alerts you to important information.
bold	Bold text denotes items that you must select or click in the software, such as menu items and dialog box options.
italic	Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. Italic text also denotes text that is a placeholder for a word or value that you must supply.
`monospace`	Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.

1

Introduction to Measurement Studio

Measurement Studio is an integrated suite of tools and class libraries that are designed for developers using Microsoft Visual Basic .NET, Visual C#, and Visual C++ to develop measurement and automation applications.

Measurement Studio dramatically reduces application development time through object-oriented measurement hardware interfaces, advanced analysis libraries, scientific user interface controls, measurement data networking, wizards, interactive code designers, and highly extensible .NET and Visual C++ classes. You can use Measurement Studio to develop a complete measurement and automation application that includes data acquisition, analysis, and presentation functionalities.

Installation Requirements

To install Measurement Studio, your computer must have the following:

- Microsoft Windows 2000/XP/XP x64[1] operating system
- Microsoft .NET Framework 1.1 (required only for the Measurement Studio .NET class libraries)
- Standard, Professional, Enterprise Developer, Enterprise Architect, or Academic edition of Microsoft Visual Studio .NET 2003 (required to use the Measurement Studio integrated tools)
- Intel Pentium II class processor, 266 MHz or higher
- Video display—800 × 600, 256 colors (16-bit color recommended for user interface controls)
- Minimum of 128 MB of RAM (256 MB or higher recommended)
- Minimum of 265 MB of free hard disk space
- Microsoft-compatible mouse
- Microsoft Internet Explorer 6.0 or later

[1] Current NI driver support for Windows XP x64 is limited.

Optional Installation—In order for links from Measurement Studio help topics to .NET Framework help topics to work, you must install the Microsoft .NET Framework SDK 1.1.

Deployment Requirements

To deploy an application built with Measurement Studio .NET class libraries, the target computer must have a Windows 2000/XP/XP x64[1] operating system and the .NET Framework version 1.1.

To deploy an application built with Measurement Studio Visual C++ class libraries, the target computer must have a Windows 2000/XP/XP x64[1] operating system.

Installation Instructions

Measurement Studio 8.0 Professional and Enterprise packages include two CDs—one with support for Visual Studio .NET 2003 and one with support for Visual Studio 6.0. The Measurement Studio 8.0 Standard package includes one CD with support for Visual Studio .NET 2003. This manual documents the Visual Studio .NET 2003 CD. For help with Visual Studio 6.0, refer to the *Measurement Studio Support for Visual Studio 6.0 Readme* located on the Measurement Studio for Visual Studio 6.0 CD.

If you install Measurement Studio 8.0 on a machine that has Measurement Studio 7.*x* installed, the installer replaces Measurement Studio 7.*x* functionality, including class libraries. The Measurement Studio 7.*x* assemblies remain in the global assembly cache (GAC); therefore, applications that reference the Measurement Studio 7.*x* version continue to use Measurement Studio 7.*x* .NET assemblies.

The default directory for Measurement Studio 8.0 (`Program Files\NationalInstruments\MeasurementStudioVS2003`) is different than the default directory for Measurement Studio 7.0 (`Program Files\NationalInstruments\MeasurementStudio70`). If Measurement Studio 7.0 is installed on your machine when you install Measurement Studio 8.0, Measurement Studio 8.0 installs to the 7.0 directory. If you prefer to install Measurement Studio 8.0 to the default 8.0 directory, you must first uninstall all Measurement Studio class libraries, including class libraries installed with National Instruments driver software, such as NI-VISA, NI-488.2, and NI-DAQmx.

[1] Current NI driver support for Windows XP x64 is limited.

Measurement Studio supports side-by-side installation of version 6.0 and 8.0. You must install Measurement Studio 6.0 and 8.0 to different directories.

Complete the following steps to install Measurement Studio. These steps describe a typical installation. Please review carefully all additional licensing and warning dialog boxes.

1. Insert the Measurement Studio CD into the CD-ROM. `autorun.exe` automatically starts. If it does not automatically start, double-click the `autorun.exe` icon.
2. Click **Install NI Measurement Studio**.
3. Enter the serial number. You can find your serial number on the Certificate of Ownership card that you received with Measurement Studio. Click **Next**.
4. Review the information in the Product Information dialog box and click **Next**.
5. Click **Next** to install all NI software to the default installation directory, or click **Browse** to select a different installation directory. You must install Measurement Studio to a local drive. Click **Next**.

Note The option to browse for an installation location is valid only if you have not already installed any Measurement Studio features. If you have any Measurement Studio features installed, then Measurement Studio installs to the same root directory to which you installed other Measurement Studio features.

6. From the feature tree, select the features you want to install. To change the Measurement Studio installation directory, select the first feature in the list and click **Browse**. Click **Next**.
7. In the Product Information dialog box, carefully review important information about the features you are installing. Click **Next**.
8. Review the license agreement and select **I accept the License Agreement(s)**. Click **Next**.
9. In the Installation Summary dialog box, review the features you selected. Click **Next**.

Note Step 9 starts the installation of Measurement Studio. Be aware that when the installer indicates that it is removing backup files, this is a normal operation. The installer may take several minutes to complete this step.

10. If prompted, insert the Device Drivers CD and select **Rescan Drive**. If not prompted, go to step 15 on this list.

11. From the feature tree, select the Device Drivers components you want to install. To change a driver installation directory, select the driver and click **Browse**. Click **Next**.
12. In the Product Information dialog box, carefully review important information about the features you are installing. Click **Next**.
13. Review the license agreement and select **I accept the License Agreement(s)**. Click **Next**.
14. In the Installation Summary dialog box, review the features you selected. Click **Next**.
15. When prompted, click the appropriate registration options.
16. Click **Finish** to complete the installation.
17. Click the appropriate restart option.

Measurement Studio Package Comparison Chart

Table 1-1 lists the features included in the Standard, Professional, and Enterprise packages of Measurement Studio. Refer to `ni.com/mstudio` for more information about the functionality and features included with each Measurement Studio package.

Table 1-1 Measurement Studio Package Comparison Chart

Feature	Standard Edition	Professional Edition	Enterprise Edition
Project Wizards	✔	✔	✔
User Interface Controls	✔	✔	✔
Standard Analysis Libraries[1]	✔	✔	✔
GPIB Class Libraries[2]	✔	✔	✔
VISA Class Libraries[2]	✔	✔	✔
NI-DAQmx Class Libraries[2]	✔	✔	✔
.NET Instrument Driver Wizard	✔	✔	✔
ActiveX Controls for Visual Basic 6.0		✔	✔

Table 1-1 Measurement Studio Package Comparison Chart (Continued)

Feature	Standard Edition	Professional Edition	Enterprise Edition
MFC and ActiveX Controls for Visual C++ 6.0		✔	✔
Professional Analysis Libraries[3]		✔	✔
3D Graph for Visual C++		✔	✔
User Interface DataSocket Binding	✔	✔	✔
DataSocket Server		✔	✔
DataSocket Library		✔	✔
Parameter Assistant		✔	✔
Instrument I/O Assistant[2]		✔	✔
DAQ Assistant[2]		✔	✔
Enterprise Analysis Libraries[4]			✔
NI-Reports			✔
NI TestStand Integration			✔
LabWindows™/CVI™ Full Development System (FDS)			✔

[1] Refer to the *Standard Analysis* section of Chapter 2, *Measurement Studio .NET Class Libraries*, for a list of the functionality included in the Standard Analysis class library.

[2] Included with the Device Drivers CD.

[3] Refer to the *Professional Analysis* section of Chapter 2, *Measurement Studio .NET Class Libraries*, for a list of the functionality included in the Professional Analysis class library.

[4] Refer to the *Enterprise Analysis* section of Chapter 2, *Measurement Studio .NET Class Libraries*, for a list of the functionality included in the Enterprise Analysis class library.

Measurement Studio Resources

As you work with Measurement Studio, you might need to consult other resources. For detailed Measurement Studio help, including function reference and in-depth documentation on developing with Measurement Studio, refer to the *NI Measurement Studio Help* within the Visual Studio .NET environment. The *NI Measurement Studio Help* is fully integrated with the Visual Studio .NET help. You must have Visual Studio .NET installed to view the online help, and you must have the Microsoft .NET Framework SDK 1.1 installed in order for links from Measurement Studio help topics to .NET Framework help topics to work. You can launch the *NI Measurement Studio Help* in the following ways:

- From the Windows Start menu, select **Start»All Programs»National Instruments»Measurement Studio 8.0 for VS .NET 2003» Measurement Studio Documentation**. The help launches in a stand-alone help viewer.
- From Visual Studio .NET, select **Help»Contents** to view the Visual Studio .NET table of contents. The *NI Measurement Studio Help* is listed in the table of contents.
- From Visual Studio .NET, select **Measurement Studio» NI Measurement Studio Help**. The help launches within the application.

Tip As you work through this manual, you will see italicized references to relevant help topics. You can find these topics by using the table of contents in the *NI Measurement Studio Help*.

The following resources also are available to provide you with information about Measurement Studio.

- Examples—Measurement Studio installs examples to the following paths, depending on whether you have previously installed Measurement Studio on your machine. If you have previously installed Measurement Studio 7.0 for Visual Studio .NET 2003, the example programs are installed to the following directories:
  - Visual Basic .NET or Visual C#—`Program Files\National Instruments\MeasurementStudio70\DotNET\Examples`
  - Visual C++—`Program Files\National Instruments\MeasurementStudio70\VCNET\Examples`

- If you have not previously installed Measurement Studio 7.0 for Windows 2000/XP, the example programs are installed to the following directories:
  - Visual Basic .NET or Visual C#—`Program Files\National Instruments\MeasurementStudioVS2003\DotNET\Examples`
  - Visual C++—`Program Files\National Instruments\MeasurementStudioVS2003\VCNET\Examples`
- NI Technical Support—Refer to Appendix A, *Technical Support and Professional Services*, for more information.
- Measurement Studio Web site, `ni.com/mstudio`—Contains Measurement Studio news, support, downloads, and evaluation software.
- NI Developer Zone, `zone.ni.com`—Provides access to online example programs, tutorials, technical news, and a Discussion Forum where you can participate in Measurement Studio discussion forums for Visual Basic, Visual C++, and Visual Studio .NET.
- *Measurement Studio .NET Class Hierarchy Chart* and *Measurement Studio Visual C++ Class Hierarchy Chart*—Provide overviews of class relationships within class libraries. Charts are included with all Measurement Studio packages and are posted online on the Manuals page at `ni.com/manuals`.

2

Measurement Studio .NET Class Libraries

This chapter provides overview information about the .NET class libraries included with Measurement Studio. Refer to the *Using the Measurement Studio .NET Class Libraries* section of the *NI Measurement Studio Help* for detailed information about these libraries. Refer to Chapter 4, *Developing with Measurement Studio*, for step-by-step instructions on developing applications with these libraries.

Measurement Studio .NET Class Library Overview

Measurement Studio provides .NET class libraries that you can use to develop complete measurement and automation applications in Visual Basic .NET and Visual C#.

Measurement Studio includes the following .NET class libraries:

- Analysis
- Common
- DataSocket
- NI-488.2
- NI-DAQmx
- NI-VISA
- User Interface

Refer to the following sections for information about each Measurement Studio .NET class library.

Analysis

The Measurement Studio Analysis .NET class library is in the `NationalInstruments.Analysis` namespace. The Analysis class library includes a set of classes that provides various digital signal processing, signal filtering, signal generation, peak detection, and other general mathematical functionality. Use this library to analyze acquired data or to generate data.

The functionality included in the Analysis library varies based on the Measurement Studio package you purchased. Refer to the following sections for information about the Standard, Professional, and Enterprise Analysis class libraries.

Standard Analysis

The Standard Analysis class library, which ships with Measurement Studio Standard Edition, includes the sawtooth, sine, square, triangle, and basic function wave generators.

Professional Analysis

The Professional Analysis class library, which ships with Measurement Studio Professional Edition, includes the Standard Analysis functionality as well as the following functionality:

- Bessel, Chebyshev, Inverse Chebyshev, Windowed, Kaiser, and Elliptic Low, High, Bandpass, and Bandstop filters
- Signal processing functions such as convolution, deconvolution, correlation, decimation, integration, and differentiation
- FFT, Inverse FFT, Real FFT, Fast Hartley, Inverse Fast Hartley, Fast Hilbert, Inverse Fast Hilbert, DST, Inverse DST, DCT, and Inverse DCT transformations
- Linear algebra functions such as determinant, check positive definiteness, calculate dot product, and other various matrix functions
- Scaled and unscaled windowing classes
- Common statistical functions such as mean, median, mode, and variance
- Exponential, linear, and polynomial curve fitting functions
- Signal generation functions

Enterprise Analysis

The Enterprise Analysis class library, which ships with Measurement Studio Enterprise Edition, includes the Standard and Professional Analysis functionality as well as the following advanced functionality:

- EquiRipple filters
- Linear algebra functions such as forward and back substitution, LU factorization, Cholesky factorization, Schur deomposition, and Hessenberg decomposition
- Probability and analysis of variance
- Sinc, impulse, pulse, ramp, and chirp patterns
- General least square curve fit, power fit, log fit, Gauss fit, cubic spline fit, and interpolation functions
- Special functions

Refer to Table 2-1 to determine the type of measurements available in the Professional and Enterprise Analysis .NET libraries.

Table 2-1. Analysis .NET Library Measurement Types included in the Professional and Enterprise Packages

Analysis .NET Library	Professional Package	Enterprise Package
Measurements		
AC and DC Estimator		✔
Amplitude and Phase Spectrum		✔
Auto Power Spectrum		✔
Cross Power Spectrum		✔
Harmonic Analyzer		✔
Impulse Response Function	✔	✔
Network Functions (avg)	✔	✔
Power and Frequency Estimate		✔
Scaled Time Domain Window		✔
Spectrum Unit Conversion		✔
Transfer Function		✔

Table 2-1. Analysis .NET Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis .NET Library	Professional Package	Enterprise Package
Signal Generation		
Arbitrary Wave	✔	✔
Chirp Pattern	✔	✔
Gaussian White Noise	✔	✔
Impulse Pattern		✔
Pulse Pattern		✔
Ramp Pattern		✔
Sawtooth Wave		✔
Sinc Pattern		✔
Sine Pattern	✔	✔
Sine Wave	✔	✔
Square Wave	✔	✔
Triangle Wave	✔	✔
Uniform White Noise	✔	✔
Windowing		
Blackman Window	✔	✔
Blackman-Harris Window	✔	✔
Blackman-Nuttall Window	✔	✔
Cosine Tapered Window	✔	✔
Dolph-Chebyshev Window	✔	✔
Exact Blackman Window	✔	✔
Exponential Window	✔	✔
Flat Top Window	✔	✔
Force Window	✔	✔
Gauss Window	✔	✔
General Cosine Window	✔	✔
Hamming Window	✔	✔

Table 2-1. Analysis .NET Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis .NET Library	Professional Package	Enterprise Package
Hanning Window	✔	✔
Kaiser Window	✔	✔
Scaled Time Domain Windows	✔	✔
Symmetric Time Domain Windows	✔	✔
Triangle Window	✔	✔
Filters		
Bessel	✔	✔
Butterworth	✔	✔
Cascade	✔	✔
Chebyshev	✔	✔
Elliptic	✔	✔
Equiripple		✔
FIR	✔	✔
FIR Windowed	✔	✔
IIR	✔	✔
IIR Cascade	✔	✔
Inverse Chebyshev	✔	✔
Kaiser	✔	✔
Signal Processing		
Autocorrelation	✔	✔
Convolution	✔	✔
Cross Correlation	✔	✔
Cross Power	✔	✔
Decimate	✔	✔
Deconvolution	✔	✔
Derivative x(t)	✔	✔

Table 2-1. Analysis .NET Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis .NET Library	Professional Package	Enterprise Package
Discrete Cosine Transform	✔	✔
Discrete Sine Transform	✔	✔
Fast Hartley Transform	✔	✔
Fast Hilbert Transform	✔	✔
Integral x(t)	✔	✔
Inverse Fast Hartley Transform	✔	✔
Inverse Fast Hilbert Transform	✔	✔
Inverse Real and Complex Fast Fourier Transform (FFT)	✔	✔
Peak Detection	✔	✔
Power Spectrum	✔	✔
Pulse Parameters	✔	✔
Real and Complex FFT	✔	✔
Threshold Peak Detector	✔	✔
Unwrap Phase		✔
Linear Algebra		
Back Transform Eigen Vectors		✔
Backward Substitution		✔
Cholesky Factorization		✔
Complex Back Transform Eigen Vectors		✔
Complex Cholesky Factorization		✔
Complex Determinant	✔	✔
Complex Dot Product	✔	✔
Complex Eigen Vectors and Eigen Values		✔
Complex General Eigen AB		✔

Table 2-1. Analysis .NET Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis .NET Library	Professional Package	Enterprise Package
Complex Hessenberg Decomposition		✔
Complex Inverse Matrix		✔
Complex Linear Equations		✔
Complex LU Factorization		✔
Complex Matrix Balance		✔
Complex Matrix Condition Number	✔	✔
Complex Matrix Norm	✔	✔
Complex Matrix Rank	✔	✔
Complex Outer Product	✔	✔
Complex Pseudo Inverse Matrix	✔	✔
Complex QR Factorization		✔
Complex QR Factorization with Pivot Matrix		✔
Complex QR Factorization with Pivot Vector		✔
Complex QZ Decomposition		✔
Complex Schur Decomposition		✔
Complex Solve Linear Equations (Multiple Right Hand)		✔
Complex Solve Linear Equations (Single Right Hand)		✔
Complex SVD Factorization		✔
Complex Vector Norm		✔
Determinant	✔	✔
Dot Product	✔	✔

Table 2-1. Analysis .NET Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis .NET Library	Professional Package	Enterprise Package
Forward Substitution		✔
General Eigen AB		✔
Hessenberg Decomposition		✔
Inverse Matrix	✔	✔
Linear Equations		✔
LU Factorization		✔
Matrix Balance		✔
Matrix Condition Number	✔	✔
Matrix Multiplication	✔	✔
Matrix Norm	✔	✔
Matrix Rank	✔	✔
Outer Product	✔	✔
Pseudo Inverse Matrix	✔	✔
QR Factorization		✔
QR Factorization with Pivot Matrix		✔
QR Factorization with Pivot Vector		✔
QZ Decomposition		✔
Schur Decomposition		✔
Solve Linear Equations (Multiple Right Hand)		✔
Solve Linear Equations (Single Right Hand)		✔
Special Matrix	✔	✔
SVD Factorization		✔
Test Positive Definite Matrix	✔	✔

Table 2-1. Analysis .NET Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis .NET Library	Professional Package	Enterprise Package
Trace	✔	✔
Transpose	✔	✔
Array and Numeric Operations		
1D and 2D Array Arithmetic	✔	✔
1D and 2D Linear Evaluation	✔	✔
1D and 2D Polynomial Evaluation	✔	✔
1D Polar to Rectangular	✔	✔
1D Rectangular to Polar	✔	✔
Complex Number Arithmetic	✔	✔
Find Polynomial Roots	✔	✔
Scale 1D and 2D	✔	✔
Curve Fitting		
Cubic Spline Fit		✔
Exponential Fit	✔	✔
Exponential Fit Interval		✔
Gauss Fit		✔
Gauss Fit Interval		✔
General Least Squares Linear Fit	✔	✔
General Polynomial Fit	✔	✔
Goodness of Fit		✔
Linear Fit	✔	✔
Linear Fit Interval		✔
Logarithm Fit		✔
Logarithm Fit Interval		✔
Nonlinear Fit	✔	✔

Table 2-1. Analysis .NET Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis .NET Library	Professional Package	Enterprise Package
Power Fit		✔
Power Fit Interval		✔
Remove Outliers		✔
Statistics		
1D, 2D, and 3D ANOVA		✔
Chi-Square Distribution		✔
erf(x) and erfc(x)		✔
F-Distribution		✔
Histogram	✔	✔
Inverse Chi-Square Distribution		✔
Inverse F-Distribution		✔
Inverse Normal Distribution		✔
Inverse T-Distribution		✔
Mean	✔	✔
Median and Mode	✔	✔
Moment about Mean	✔	✔
Normal Distribution		✔
Polynomial Interpolation		✔
RMS	✔	✔
Spline Interpolant		✔
Spline Interpolation		✔
Standard Deviation	✔	✔
T-Distribution		✔
Variance		✔

Table 2-1. Analysis .NET Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis .NET Library	Professional Package	Enterprise Package
Special Functions		
Airy		✔
Bessel 1st		✔
Bessel 2nd		✔
Beta		✔
Complimentary Gamma		✔
Cosine Integral		✔
Dawson's Integral		✔
Dilogarithm		✔
Elliptic 1st		✔
Elliptic 2nd		✔
Exponential Integral		✔
Factorial		✔
Fresnel Integrals		✔
Gamma		✔
Gauss HyperGeometric		✔
Hyperbolic Cosine Integral		✔
Hyperbolic Sine Integral		✔
Incomplete Beta		✔
Incomplete Elliptic 1st		✔
Incomplete Elliptic 2nd		✔
Incomplete Gamma		✔
Jacobian Elliptic Function		✔
Kelvin 1st		✔
Kelvin 2nd		✔
Kummer		✔
Logarithm of Factorial		✔

Table 2-1. Analysis .NET Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis .NET Library	Professional Package	Enterprise Package
Modified Bessel 1st		✔
Modified Bessel 2nd		✔
Parabolic Cylinder		✔
Psi		✔
Sine Integral		✔
Spherical Bessel 1st		✔
Spherical Bessel 2nd		✔
Stirling		✔
Struve		✔
Tricomi		✔
Zeta		✔

Tip For more information about analyzing or generating data with the Analysis class library, refer to the *Using the Measurement Studio Analysis .NET Library* topic in the *NI Measurement Studio Help*. For more information about the functionality included in the Analysis class library, visit `ni.com/analysis` and select **Analysis in Measurement Studio**.

Common

The Measurement Studio Common .NET class library is in the `NationalInstruments` namespace. The Common class library provides a set of classes that facilitates the exchange of data between the acquisition, analysis, and user interface portions of your application. The Common class library includes the following features:

- A `ComplexDouble` data type. This data type represents a complex number of type `Double` that is composed of a real part and an imaginary part.
- A `DigitalWaveform` data type. This data type represents a set of digital states that are grouped by samples or signals.

- A `DataConverter` class that converts data from one data type to another data type, such as converting an array of integers to an array of doubles.
- An `EngineeringFormatInfo` class that defines a custom formatter to format numeric values with engineering notation and International System of Units (SI) prefixes and symbols.

Tip For more detailed information about the Common class library, refer to the *NationalInstruments* section in the *NI Measurement Studio Help*.

DataSocket

The Measurement Studio DataSocket .NET class library is in the `NationalInstruments.Net` namespace. Use the DataSocket class library to transfer live measurement data over the Internet or an intranet, between applications on the same computer, and to and from files. Use the classes in the DataSocket class library to perform the following operations:

- Read and write data between different data sources and targets.
- Use a single, simple API to communicate with several types of servers, including DataSocket Servers (`dstp:`), Web servers (`http:`), file transfer protocol servers (`ftp:`), file systems (`file:`), and OLE for Process Control (`opc:`) servers.
- Specify data sources and targets using a URL, the same way you access Web pages in a Web browser.
- Use DataSocket Transfer Protocol (DSTP) to exchange different types of data.
- Expose DataSocket data items as data sources that you can bind to properties of a Windows Forms control.
- Interactively browse to quickly locate and select data items on other computers and servers.

NI-488.2

The Measurement Studio NI-488.2 .NET class library is in the `NationalInstruments.NI4882` namespace. This class library is included when you install the NI-488.2 driver. The NI-488.2 class library includes a set of classes for communicating with GPIB instruments, controlling GPIB devices, and acquiring GPIB status information. Use this library to design code that communicates with and controls instruments on

a GPIB interface. Use the NI-488.2 class library to configure and communicate with GPIB devices using the `Device` and `Board` classes.

Tip For information about easily creating a Measurement Studio NI-488.2 application using the Instrument I/O Assistant, refer to the *Creating a Measurement Studio NI-488.2 or NI-VISA Application* section of Chapter 4, *Developing with Measurement Studio*. For more information about GPIB, visit `ni.com/gpib`.

NI-DAQmx

The Measurement Studio NI-DAQmx .NET class library is in the `NationalInstruments.DAQmx` namespace. This class library is included when you install the NI-DAQmx driver. Use the NI-DAQmx class library to communicate with and control NI data acquisition (DAQ) devices.

Note Some DAQ devices are not currently supported by the NI-DAQmx driver. Refer to the *NI-DAQ Readme* for a complete listing of supported hardware.

Use the NI-DAQmx class library to perform the following types of tasks:

- Analog signal measurement
- Analog signal generation
- Digital I/O
- Counting and timing
- Pulse generation
- Signal switching

Tip For information about easily creating a NI-DAQmx application using the DAQ Assistant, refer to the *Creating a Measurement Studio NI-DAQmx Application* or *Walkthrough: Creating a Measurement Studio NI-DAQmx Application* sections of Chapter 4, *Developing with Measurement Studio*. For more information about DAQ, visit `ni.com/daq`.

NI-VISA

The Measurement Studio NI-VISA .NET class library is in the `NationalInstruments.VisaNS` namespace. This class library is included when you install the NI-VISA driver. The NI-VISA class library includes a set of classes that provides a rich, object-oriented interface to the NI-VISA driver. Use this library to quickly create bus-independent and/or bus-specific instrument control applications.

The NI-VISA class library supports formatted I/O operations, locking, event handling, and interface-specific extensions. With this class library you can access the functionality available in NI-VISA for communicating with message-based and register-based instruments using the following interfaces:

- GPIB
- IEEE 1394
- PXI
- Serial (RS-232 and RS-485)
- TCP/IP
- USB
- VXI

Tip For information about easily creating a Measurement Studio NI-VISA application using the Instrument I/O Assistant, refer to the *Creating a Measurement Studio NI-488.2 or NI-VISA Application* or *Walkthrough: Creating a Measurement Studio Instrument I/O Application* sections of Chapter 4, *Developing with Measurement Studio*. For more information about NI-VISA, visit `ni.com/visa`.

User Interface

The Measurement Studio user interface controls are in the Windows Forms .NET class library. The Windows Forms .NET class library is in the `NationalInstruments.UI.WindowsForms` namespace. The Windows Forms class library encapsulates the following Measurement Studio user interface controls:

- Waveform graph
- Scatter graph
- Digital waveform graph
- Complex graph

- Legend
- Knob
- Gauge
- Meter
- Slide
- Thermometer
- Tank
- Numeric edit
- Switch
- LED
- Property editor

Use this class library to add measurement-specific user interface controls to your application. You can configure the controls programmatically at design time, through the Properties window in the Windows Forms Designer, or at run time with the property editor control. The following sections describe each of the Measurement Studio user interface controls.

Tip For more information about easily using the .NET user interface controls, refer to the *Using the Measurement Studio Windows Forms .NET Controls* section in the *NI Measurement Studio Help*.

Waveform Graph and Scatter Graph Controls

Use the Measurement Studio waveform graph and scatter graph controls, as shown in Figure 2-1, to display two-dimensional data on a Windows Forms user interface. Use the waveform graph to display data that is uniformly spaced in one dimension. Use the scatter graph to display data that is arbitrarily spaced in two dimensions.

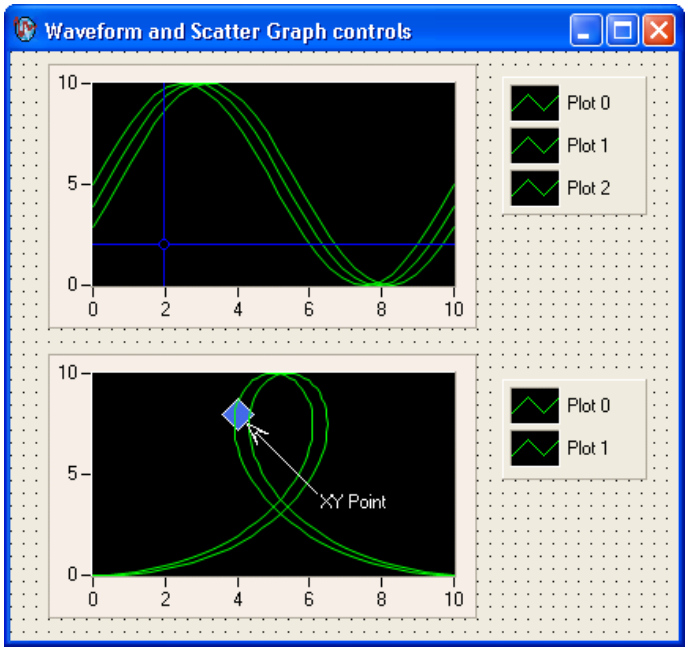


Figure 2-1. Waveform Graph with Cursors and Scatter Graph with XY Point Annotation; Both Graphs Have Corresponding Legends

With the waveform graph and scatter graph controls and the classes that interface with the controls, you can perform the following operations:

Plot Operations

- Plot and chart data.
- Configure a graph to contain multiple plots to show separate but related data on the same graph.
- Draw lines or fills from a plot to an X value, Y value, or another plot.
- Specify plots in the scatter graph control as X and Y data. Specify plots in the waveform graph control as X or Y data and optionally with date and time scaling.
- Use the extensible plot and plot area drawing capabilities and events to customize the graph appearance.
- Use plot data tooltips to display X and Y coordinates when a user hovers the mouse over a data point.
- Create custom point and line styles for plots.
- Specify anti-aliased plots for plot lines.

Axis Operations

- Configure a graph to include multiple axes or independent ranges so that plot data fits the graph plot area.
- Configure the axis modes to fixed, exact autoscaling, loose autoscaling, strip chart, or scope chart.
- Use logarithmic axes with configurable bases.

Cursor Operations

- Use cursors to identify key points in plots and the plot area.
- Configure cursor snap modes to be fixed, floating, nearest point, and to plot.
- Use cursor labels to display X and Y data coordinates that the cursor crosshair points to, and customize the text font and colors of the label.
- Create custom point and line styles for cursors.

Annotation Operations

- Configure text labels, arrows, and drawing shapes to annotate a point anywhere in the plot area of the graph.
- Configure range area, text labels, and arrows to annotate a range in the plot area of the graph.

Additional Operations

- Pan and zoom interactively.
- Configure major, minor, and custom divisions and origin lines.
- Copy the graph as a BMP, GIF, JPEG, or PNG image to the clipboard or a file.

Tip For more information about using the waveform and scatter graph controls, refer to the *Using the Measurement Studio Graph .NET Controls* section in the *NI Measurement Studio Help*.

Digital Waveform Graph Control

Use the Measurement Studio digital waveform graph control, as shown in Figure 2-2, to display `DigitalWaveform` data on a Windows Forms user interface.

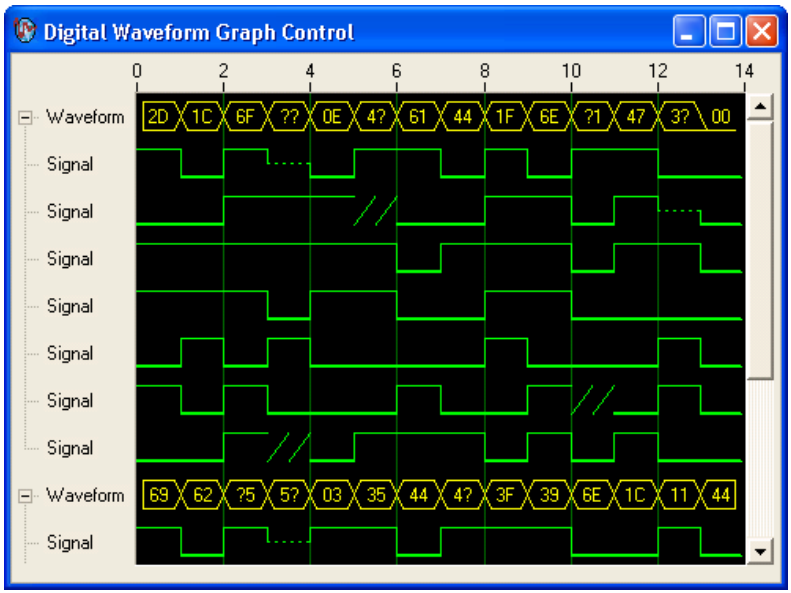


Figure 2-2. .NET Digital Graph

With the digital waveform graph control and the classes that interface with the control, you can perform the following operations:

Plot Operations

- Plot digital waveform data, including eight different digital states.
- Configure plot labels on the y-axis.
- Configure plot templates to customize plots that are implicitly created from plotted data.
- Specify anti-aliased digital plots.
- Expand and collapse signal plots interactively.

Waveform and Signal State Operations

- Simultaneously display waveforms and signals or display signals only.
- Create custom waveform and signal state styles.
- Configure state labels.
- Create custom waveform state labels.

Additional Operations

- Display data in sample or time mode.
- Pan with scroll bars.
- Configure the style and mode of scroll bars.
- Create custom scroll bars.
- Configure the axis modes to exact or loose autoscaling or fixed.
- Pan and zoom interactively.
- Configure major, minor, and custom divisions.
- Copy the graph as a BMP, GIF, JPEG, or PNG image to the clipboard or a file.

Tip For more information about using the digital waveform graph control, refer to the *Using the Measurement Studio Graph .NET Controls* section in the *NI Measurement Studio Help*.

Complex Graph Control

Use the Measurement Studio complex graph control, as shown in Figure 2-3, to display `ComplexDouble` data on a Windows Forms user interface. A `ComplexDouble` consists of a real part and an imaginary part.

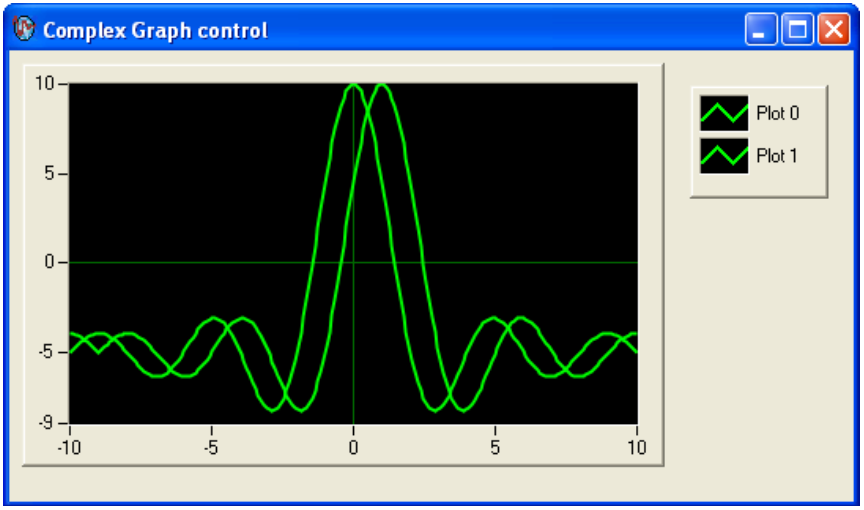


Figure 2-3. .NET Complex Graph

With the complex graph control and the classes that interface with the control, you can perform the following operations:

Plot Operations

- Plot and chart `ComplexDouble` data.
- Configure a graph to contain multiple plots to show separate but related data on the same graph.
- Draw lines or fills from a plot to an X value, Y value, or another plot.
- Use the extensible plot and plot area drawing capabilities and events to customize the graph appearance.
- Create custom point and line styles for plots.
- Specify anti-aliased plots for plot lines.

Axis Operations

- Configure a graph to include multiple axes or independent ranges so that plot data fits the graph plot area.
- Configure the axis modes to fixed, exact autoscaling, loose autoscaling, strip chart, or scope chart.

Additional Operations

- Pan and zoom interactively.
- Configure major, minor, and custom divisions and origin lines.
- Copy the graph as a BMP, GIF, JPEG, or PNG image to the clipboard or a file.

Tip For more information about using the complex graph control, refer to the *Using the Measurement Studio Graph .NET Controls* section in the *NI Measurement Studio Help*.

Legend Control

Use the Measurement Studio legend control, as shown in Figure 2-1, to display symbols and descriptions for a specific set of elements of another object, such as the plots or cursors of a graph. When you associate the legend control with another object, any changes you make to that object are automatically reflected in the legend. For example, if you associate the legend control with the plots of a graph, any changes you make in the plots collection editor are automatically reflected in the legend.

Tip For more information about using the legend control, refer to the *Using the Measurement Studio Legend .NET Control* section in the *NI Measurement Studio Help*.

Numeric Controls

Use the Measurement Studio numeric controls to display numerical information on a Windows Forms user interface with the look of scientific instruments. The numeric controls include a knob, gauge, meter, slide, thermometer, and tank. The following sections describe operations available with the controls and the classes that interface with them.

With all of the numeric controls and the classes that interface with them, you can perform the following operations:

- Configure the scale to be linear or logarithmic and toggle the visibility of the scale.
- Fill the scale and configure the range, color, dimensions, and style of the fill.
- Bind the value to a .NET data source using .NET data binding.
- Connect to the Measurement Studio .NET numeric edit control so that if you change the value of one control, it changes the value of the other control.
- Customize the appearance of the control using 3D lab styles or classic 2D styles and change the color and length of ticks and labels.
- Configure the format of value labels to engineering or date/time.

Use the Measurement Studio knob, gauge, and meter controls, as shown in Figure 2-4, to input and display numeric data on your user interface.

Figure 2-4. Knob, Gauge, and Meter .NET Controls

With the knob, gauge, and meter controls and the classes that interface with the controls, you can perform the following operations:

- Specify the start and sweep angle of the arc programmatically or from the Properties window.
- Use automatic division spacing and custom divisions, and invert the scale to counter-clockwise.

Use the Measurement Studio slide, tank, and thermometer controls, as shown in Figure 2-5, to input and display numeric data on your interface.

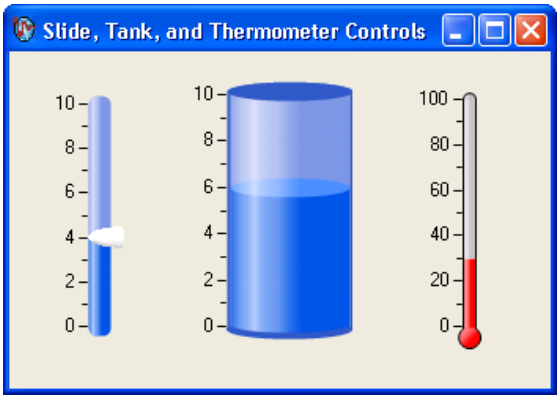


Figure 2-5. .NET Slide, Tank, and Thermometer Controls

With the slide, tank, and thermometer controls and the classes that interface with them, you can perform the following operations:

- Fill the minimum or maximum value of the scale.
- Position the scale horizontally with left, right, or both and position the scale vertically with top, bottom, or both.

Tip For more information about using the knob, gauge, meter, slide, tank, or thermometer controls, refer to the *Knob*, *Gauge*, *Meter*, *Slide*, *Tank*, or *Thermometer Class* sections in the *NI Measurement Studio Help*.

Numeric Edit Control

Use the Measurement Studio numeric edit control, as shown in Figure 2-6, to display numeric values and to provide a way by which end users can edit numeric values. Typically, you use a numeric edit control to input or display double numerical data instead of using a Windows Forms TextBox or NumericUpDown control.

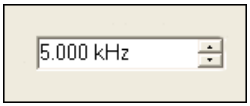


Figure 2-6. Numeric Edit Control

With the numeric edit control and the classes that interface with the control you can perform the following operations:

- Use up/down buttons for easy incrementing and decrementing.
- Perform range checking.
- Set the minimum range value to negative infinity and the maximum range value to positive infinity.
- Create custom formats or use built-in numeric formats including generic, engineering, and simple double.
- Connect to a numeric control so that if you change the value of one control, it changes the value of the other control.
- Set the coercion mode property to discrete or continuous values. This property configures the control to allow entry or display of either a discrete set of values or any value.
- Set the interaction mode to keyboard and mouse, keyboard only, mouse only, or none.
- Use the edit box to select text programmatically and to validate text values.

Tip For more information about using the numeric edit control, refer to the *NumericEdit Class* section in the *NI Measurement Studio Help*.

Switch and LED Controls

Use the Measurement Studio switch and LED controls as Boolean controls on a Windows Forms user interface. You typically use a switch control, as shown in Figure 2-7, to receive and control Boolean input on an application user interface.

Figure 2-7. Switch Control in Vertical Toggle 3D Style

You typically use an LED control, as shown in Figure 2-8, to indicate a Boolean value on an application user interface.

Figure 2-8. LED Control in Square 3D style

With the switch and LED controls and the classes that interface with the controls, you can perform the following operations:

- Receive notification before or after the state of the control changes.
- Configure how the control behaves when you click it with the mouse or press the spacebar when the control has focus.
- Configure the appearance of the control.
- Make the control background transparent.
- Configure the LED control to blink while it is on or off and configure the rate at which the LED control blinks.

Tip For more information about using the switch and LED controls, refer to the *Using the Measurement Studio Switch and LED .NET Controls* section in the *NI Measurement Studio Help*.

Property Editor Control

Use the Measurement Studio property editor control, as shown in Figure 2-9, to configure properties for Windows Forms controls at run time.

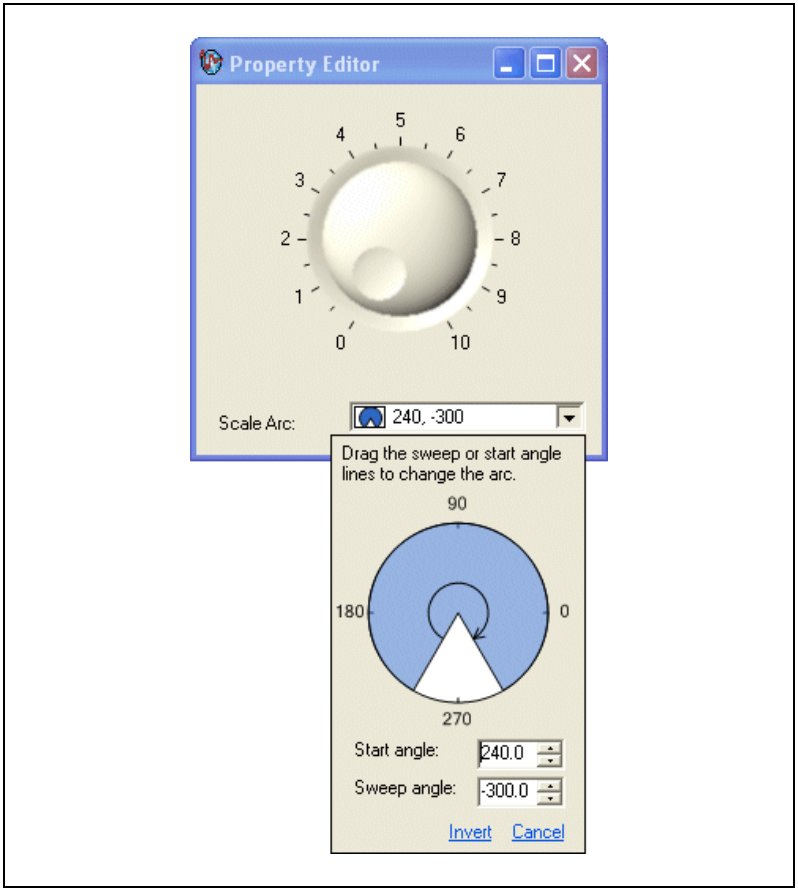


Figure 2-9. Property Editor Control for the Knob Control Scale Arc Property

With the property editor control and the classes that interface with the control, you can perform the following operations:

- Edit any .NET type at run time, including collections.
- Edit expandable properties that represent nested properties of another object, such as major divisions of an axis.
- Create custom editors and type converters for properties.

- Connect to a Windows Forms control so that if you change the value of a property of the control, the Property Editor will update to reflect the change.
- Configure the display mode as a visual representation of the value, text-only, or both.
- Set the interaction mode to edit values or indicator.

3

Measurement Studio Visual C++ Class Libraries

This chapter provides overview information about the Visual C++ class libraries that are available with Measurement Studio. Refer to the *Using the Measurement Studio Visual C++ Class Libraries* section of the *NI Measurement Studio Help* for detailed information about these libraries.

Measurement Studio Visual C++ Class Library Overview

Measurement Studio provides libraries of MFC-based classes that you can use to develop complete measurement and automation applications in Visual C++.

Measurement Studio includes the following Visual C++ class libraries:

- 3D Graph
- Analysis
- Common
- DataSocket
- Instrument Drivers
- LabVIEW Real-Time Interface
- Microsoft Excel Interface
- Microsoft Word Interface
- NI-488.2
- NI-DAQmx
- NI-Reports
- NI-VISA
- User Interface
- Utility

Refer to the following sections for information about each Measurement Studio Visual C++ class library.

ActiveX Controls in Visual C++

ActiveX controls are specialized COM servers that implement a specific set of interfaces. The Measurement Studio Visual C++ button, graph, knob, numeric edit, slide, and 3D graph are ActiveX controls. Measurement Studio includes classes that provide native C++ interfaces to the ActiveX controls. For example, the `CNiGraph` class provides an interface to the CWGraph ActiveX graph control.

The Measurement Studio classes that provide interfaces to the Measurement Studio ActiveX controls simplify using ActiveX controls in Visual C++ interfaces and programs. The features that simplify this process include overloaded functions, the ability to call the control from any thread, and automatic data type translations.

3D Graph Control

Use the Measurement Studio ActiveX 3D graph control, as shown in Figure 3-1, to plot three-dimensional data. The 3D graph is included only in the Measurement Studio Enterprise package.

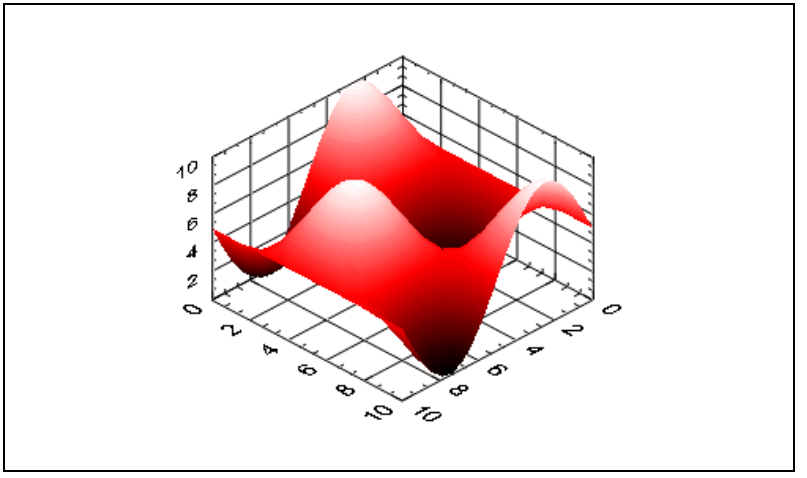


Figure 3-1. ActiveX 3D Graph Control

With the Measurement Studio ActiveX 3D graph control and the classes that interface with the control, you can perform the following operations:

Plot Operations

- Plot three-dimensional data, including curves and surfaces.
- Use multiple plot styles—point-line, line-point, hidden-line, contour, surface, surface-line, surface-contour, and surface-normal.
- Create multiple plots with individual properties, such as name, line and point style, width, and base value.
- Configure the control to render directly to OpenGL-enabled hardware accelerator cards.
- Bind the control to a DataSocket Server to enable automatic read and write functionality.

Additional Operations

- Configure the axes using customizable ticks, labels, value pairs, and captions.
- Use legends and plane projections.
- Use cartesian, cylindrical, and spherical coordinate systems.
- Customize the control using color maps, transparency, and lighting.
- Display in orthographic and perspective views.
- Use built-in format styles for labels including scientific, symbolic engineering, scaling, time, and date.
- Rotate, pan, and zoom interactively.

Tip For information about easily creating graphs with the 3D graph control library, refer to the *3D Graph Visual C++ Class Library Overview* topic in the *NI Measurement Studio Help*.

Analysis

The Analysis class library includes a set of classes that provides various digital signal processing, signal filtering, signal generation, peak detection, and other general mathematical functionality. Use this library to analyze acquired data or to generate data.

The functionality included in the Analysis library varies based on the Measurement Studio package you purchased. Refer to the following

sections for information about the Standard, Professional, and Enterprise Analysis class libraries.

Standard Analysis

The Standard Analysis class library, which ships with Measurement Studio Standard Edition, includes the sawtooth, sine, square, triangle, and basic function wave generators.

Professional Analysis

The Professional Analysis class library, which ships with Measurement Studio Professional Edition, includes the Standard Analysis functionality as well as the following functionality:

- Bessel, Chebyshev, Inverse Chebyshev, Windowed, Kaiser, and Elliptic Low, High, Bandpass, and Bandstop filters
- Signal processing functions such as convolution, deconvolution, correlation, decimation, integration, and differentiation
- FFT, Inverse FFT, Real FFT, Fast Hartley, Inverse Fast Hartley, Fast Hilbert, Inverse Fast Hilbert, DST, Inverse DST, DCT, and Inverse DCT transformations
- Linear algebra functions such as determinant, check positive definiteness, calculate dot product, and other various matrix methods
- Scaled and unscaled windowing classes
- Common statistical functions such as mean, median, mode, and variance
- Exponential, linear, and polynomial curve fitting functions
- Signal generation functions

Enterprise Analysis

The Enterprise Analysis class library, which ships with Measurement Studio Enterprise Edition, includes the Standard and Professional Analysis functionality as well as the following advanced functionality:

- EquiRipple filters
- Linear algebra functions such as forward and back substitution, LU factorization, Cholesky factorization, Schur decomposition, and Hessenberg decomposition
- Probability and analysis of variance
- Sinc, impulse, pulse, ramp, and chirp patterns

- General least square curve fit, power fit, log fit, Gauss Fit, cubic spline fit, and interpolation functions
- Special functions

Refer to Table 3-1 to determine the type of measurements available in the Professional and Enterprise Analysis C++ libraries.

Table 3-1. Analysis C++ Library Measurement Types included in the Professional and Enterprise Packages

Analysis Visual C++ Library	Professional Package	Enterprise Package
Measurements		
AC and DC Estimator		✔
Amplitude and Phase Spectrum		✔
Auto Power Spectrum		✔
Cross Power Spectrum		✔
Harmonic Analyzer		✔
Impulse Response Function	✔	✔
Network Functions (avg)	✔	✔
Power and Frequency Estimate		✔
Scaled Time Domain Window		✔
Spectrum Unit Conversion		✔
Transfer Function		✔
Signal Generation		
Arbitrary Wave	✔	✔
Chirp Pattern	✔	✔
Gaussian White Noise	✔	✔
Impulse Pattern		✔
Pulse Pattern		✔
Ramp Pattern		✔
Sawtooth Wave		✔
Sinc Pattern		✔

Table 3-1. Analysis C++ Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis Visual C++ Library	Professional Package	Enterprise Package
Sine Pattern		✔
Sine Wave	✔	✔
Square Wave	✔	✔
Triangle Wave	✔	✔
Uniform White Noise	✔	✔
Windowing		
Blackman Window	✔	✔
Blackman-Harris Window	✔	✔
Blackman-Nuttall Window	✔	✔
Cosine Tapered Window	✔	✔
Dolph-Chebyshev Window	✔	✔
Exact Blackman Window	✔	✔
Exponential Window	✔	✔
Flat Top Window	✔	✔
Force Window	✔	✔
Gauss Window	✔	✔
General Cosine Window	✔	✔
Hamming Window	✔	✔
Hanning Window	✔	✔
Kaiser Window	✔	✔
Scaled Time Domain Windows	✔	✔
Symmetric Time Domain Windows	✔	✔
Triangle Window	✔	✔
Filters		
Bessel	✔	✔
Butterworth	✔	✔

Table 3-1. Analysis C++ Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis Visual C++ Library	Professional Package	Enterprise Package
Cascade	✔	✔
Chebyshev	✔	✔
Elliptic	✔	✔
Equiripple		✔
FIR	✔	✔
FIR Windowed	✔	✔
IIR	✔	✔
IIR Cascade	✔	✔
Inverse Chebyshev	✔	✔
Kaiser	✔	✔
Signal Processing		
Autocorrelation	✔	✔
Convolution	✔	✔
Cross Correlation	✔	✔
Cross Power	✔	✔
Decimate	✔	✔
Deconvolution	✔	✔
Derivative x(t)	✔	✔
Discrete Cosine Transform	✔	✔
Discrete Sine Transform	✔	✔
Fast Hartley Transform	✔	✔
Fast Hilbert Transform	✔	✔
Integral x(t)	✔	✔
Inverse Fast Hartley Transform	✔	✔
Inverse Fast Hilbert Transform	✔	✔
Inverse Real and Complex Fast Fourier Transform (FFT)	✔	✔

Table 3-1. Analysis C++ Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis Visual C++ Library	Professional Package	Enterprise Package
Peak Detection	✔	✔
Power Spectrum	✔	✔
Pulse Parameters	✔	✔
Real and Complex FFT	✔	✔
Threshold Peak Detector	✔	✔
Unwrap Phase	✔	✔
Linear Algebra		
Back Transform Eigen Vectors		✔
Backward Substitution		✔
Cholesky Factorization		✔
Complex Back Transform Eigen Vectors		✔
Complex Cholesky Factorization		✔
Complex Determinant	✔	✔
Complex Dot Product	✔	✔
Complex Eigen Vectors and Eigen Values		✔
Complex General Eigen AB		✔
Complex Hessenberg Decomposition		✔
Complex Inverse Matrix		✔
Complex Linear Equations		✔
Complex LU Factorization		✔
Complex Matrix Balance		✔
Complex Matrix Condition Number	✔	✔
Complex Matrix Norm	✔	✔

Table 3-1. Analysis C++ Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis Visual C++ Library	Professional Package	Enterprise Package
Complex Matrix Rank	✔	✔
Complex Outer Product	✔	✔
Complex Pseudo Inverse Matrix	✔	✔
Complex QR Factorization		✔
Complex QR Factorization with Pivot Matrix		✔
Complex QR Factorization with Pivot Vector		✔
Complex QZ Decomposition		✔
Complex Schur Decomposition		✔
Complex Solve Linear Equations (Multiple Right Hand)		✔
Complex Solve Linear Equations (Single Right Hand)		✔
Complex SVD Factorization		✔
Complex Vector Norm		✔
Determinant	✔	✔
Dot Product	✔	✔
Forward Substitution		✔
General Eigen AB		✔
Hessenberg Decomposition		✔
Inverse Matrix	✔	✔
Linear Equations		✔
LU Factorization		✔
Matrix Balance		✔
Matrix Condition Number	✔	✔

Table 3-1. Analysis C++ Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis Visual C++ Library	Professional Package	Enterprise Package
Matrix Multiplication	✔	✔
Matrix Norm	✔	✔
Matrix Rank	✔	✔
Outer Product	✔	✔
Pseudo Inverse Matrix	✔	✔
QR Factorization		✔
QR Factorization with Pivot Matrix		✔
QR Factorization with Pivot Vector		✔
QZ Decomposition		✔
Schur Decomposition		✔
Solve Linear Equations (Multiple Right Hand)		✔
Solve Linear Equations (Single Right Hand)		✔
Special Matrix	✔	✔
SVD Factorization		✔
Test Positive Definite Matrix	✔	✔
Trace	✔	✔
Transpose	✔	✔
Array and Numeric Operations		
1D and 2D Array Arithmetic	✔	✔
1D and 2D Linear Evaluation	✔	✔
1D and 2D Polynomial Evaluation	✔	✔
1D Polar to Rectangular	✔	✔
1D Rectangular to Polar	✔	✔

Table 3-1. Analysis C++ Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis Visual C++ Library	Professional Package	Enterprise Package
Complex Number Arithmetic	✔	✔
Find Polynomial Roots	✔	✔
Scale 1D and 2D	✔	✔
Curve Fitting		
Cubic Spline Fit		✔
Exponential Fit	✔	✔
Exponential Fit Interval		✔
Gauss Fit		✔
Gauss Fit Interval		✔
General Least Squares Linear Fit	✔	✔
General Polynomial Fit	✔	✔
Goodness of Fit		✔
Linear Fit	✔	✔
Linear Fit Interval		✔
Logarithm Fit		✔
Logarithm Fit Interval		✔
Nonlinear Fit	✔	✔
Power Fit		✔
Power Fit Interval		✔
Remove Outliers		✔
Statistics		
1D, 2D, and 3D ANOVA		✔
Chi-Square Distribution		✔
erf(x) and erfc(x)		✔
F-Distribution		✔
Histogram	✔	✔

Table 3-1. Analysis C++ Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis Visual C++ Library	Professional Package	Enterprise Package
Inverse Chi-Square Distribution		✔
Inverse F-Distribution		✔
Inverse Normal Distribution		✔
Inverse T-Distribution		✔
Mean	✔	✔
Median and Mode	✔	✔
Moment about Mean	✔	✔
Normal Distribution		✔
Polynomial Interpolation		✔
RMS	✔	✔
Spline Interpolant		✔
Spline Interpolation		✔
Standard Deviation	✔	✔
T-Distribution		✔
Variance		✔
Special Functions		
Airy		✔
Bessel 1st		✔
Bessel 2nd		✔
Beta		✔
Complimentary Gamma		✔
Cosine Integral		✔
Dawson’s Integral		✔
Dilogarithm		✔
Elliptic 1st		✔
Elliptic 2nd		✔

Table 3-1. Analysis C++ Library Measurement Types included in the Professional and Enterprise Packages (Continued)

Analysis Visual C++ Library	Professional Package	Enterprise Package
Exponential Integral		✔
Factorial		✔
Fresnel Integrals		✔
Gamma		✔
Gauss HyperGeometric		✔
Hyperbolic Cosine Integral		✔
Hyperbolic Sine Integral		✔
Incomplete Beta		✔
Incomplete Elliptic 1st		✔
Incomplete Elliptic 2nd		✔
Incomplete Gamma		✔
Jacobian Elliptic Function		✔
Kelvin 1st		✔
Kelvin 2nd		✔
Kummer		✔
Logarithm of Factorial		✔
Modified Bessel 1st		✔
Modified Bessel 2nd		✔
Parabolic Cylinder		✔
Psi		✔
Sine Integral		✔
Spherical Bessel 1st		✔
Spherical Bessel 2nd		✔
Stirling		✔
Struve		✔
Tricomi		✔
Zeta		✔

Tip For more information about analyzing or generating data with the Analysis class library, refer to the *Using the Measurement Studio Analysis Visual C++ Library* topic in the *NI Measurement Studio Help*. For more information about the functionality included in the Analysis class library, visit `ni.com/analysis` and select **Analysis in Measurement Studio**.

Common

The Measurement Studio Common Visual C++ class library provides data types and classes that other Measurement Studio Visual C++ class libraries use. The classes that are implemented natively in Visual C++ include the `CNiVector` and `CNiMatrix` classes.

The Common class library includes the following data types:

- `CNiScalarVector`—Implements a vector object that contains scalar numbers.
- `CNiScalarMatrix`—Implements a matrix object that contains scalar numbers.
- `CNiString`—Extends the MFC CString class with streaming operators for a variety of data types and with various other string manipulation functions.
- `CNiScalarVector`—Implements a vector object that contains scalar numbers.
- `CNiVariant`—Extends the MFC COleVariant class with additional constructors and assignment operators for CNiComplex-, CNiVector-, and CNiMatrix-derived objects and with cast operators to convert CNiVariant objects to a variety of other object types.
- `CNiException`—Extends the MFC CException class and serves as the base class for many Measurement Studio exceptions.
- `CNiRegKey`—Encapsulates the interface to the Windows registry. Use this class and related classes to open and create keys, get keys, and get values associated with those keys.

Tip For more detailed information about the Common class library, refer to the *Common Visual C++ Class Library Overview* topic in the *NI Measurement Studio Help*.

DataSocket

Use the Measurement Studio DataSocket Visual C++ class library to transfer live measurement data over the Internet or an intranet, between applications on the same computer, and to and from files. Use the classes in the DataSocket Visual C++ class library to perform the following operations:

- Read and write data between different data sources and targets.
- Use a single, simple API to communicate with several types of servers, including DataSocket Servers (`dstp:`), Web servers (`http:`), file transfer protocol servers (`ftp:`), file systems (`file:`), and OLE for Process Control (`opc:`) servers.
- Specify data sources and targets using a URL, the same way you access Web pages in a Web browser.
- Use DataSocket Transfer Protocol (DSTP) to exchange different types of data.
- Interactively browse to quickly locate and select data items on other computers and servers.

Instrument Drivers

Measurement Studio includes a set of class libraries that provides Visual C++ classes that you can use to program instruments, such as digital multimeters and oscilloscopes. These Visual C++ classes provide Visual C++ interfaces to ANSI C DLL-based Interchangeable Virtual Instrument (IVI) class drivers. Each Measurement Studio instrument driver class library includes a set of Visual C++ classes that interfaces to a single IVI driver. The Measurement Studio Visual C++ classes provide enhancements to the ANSI C interface, such as automatic data type translation and organization of properties and methods into a logical hierarchy. Each class driver provides a consistent interface to a particular type of device. Measurement Studio includes the following class driver class libraries:

- `IviDcPwr`—Provides an interface to the IVI DC power supply class driver. `CNiIviDcPwr` is the top-level class of this class library.
- `IviDmm`—Provides an interface to the IVI DMM class driver. `CNiIviDmm` is the top-level class of this class library.
- `IviFgen`—Provides an interface to the IVI arbitrary waveform generator class driver. `CNiIviFgen` is the top-level class of this class library.

- `IviScope`—Provides an interface to the IVI oscilloscope class driver. `CNiIviScope` is the top-level class of this class library.
- `IviSwitch`—Provides an interface to the IVI switch class driver. `CNiIviSwtch` is the top-level class of this class library.

LabVIEW Real-Time Interface

Use the Measurement Studio LabVIEW Real-Time Interface Visual C++ class library to read from and write to shared memory on a LabVIEW RT Series processor board. Use shared memory to pass data between LabVIEW RT VIs and your application. Use this class library both from an application that runs on the host machine and from a DLL that you download to the board.

Note The LabVIEW RT DLLs you create with the Measurement Studio LabVIEW RT Interface Visual C++ class library work only with LabVIEW Real-Time Module 6.0 or later.

Tip For more information about using the LabVIEW Real-Time Module, refer to the *LabVIEW Real-Time Interface Visual C++ Class Library Overview* topic in the *NI Measurement Studio Help*. For more information about the LabVIEW Real-Time Module, visit `ni.com/labviewrt`.

Microsoft Excel Interface

Use the Measurement Studio Excel Visual C++ class library to automatically create Excel spreadsheets and charts from within measurement and automation applications. Use the Microsoft Excel Interface class library to perform offline processing of the measurement and automation data you acquire and analyze using other Measurement Studio Visual C++ classes. This class library is included only in the Measurement Studio Enterprise package.

Tip For more information about using the Measurement Studio Excel Visual C++ class library to create applications that present data in Microsoft Excel format, refer to the *Microsoft Excel Interface Visual C++ Class Library Overview* topic in the *NI Measurement Studio Help*.

Microsoft Word Interface

Use the Measurement Studio Microsoft Word Interface Visual C++ class library to automatically create Word documents from within measurement and automation applications. Use the Microsoft Word Interface class library to perform offline processing of the measurement and automation data you acquire and analyze using other Measurement Studio Visual C++ classes. This class library is included only in the Measurement Studio Enterprise package.

Tip For more information about using the Measurement Studio Word Visual C++ class library to create applications that present data in Microsoft Word, refer to the *Microsoft Word Interface Visual C++ Class Library Overview* topic in the *NI Measurement Studio Help*.

NI-488.2

Use the Measurement Studio NI-488.2 Visual C++ class library to communicate with and control instruments on a GPIB interface. This class library is included when you install the NI-488.2 driver. Use this class library to configure and communicate with GPIB devices using the `Device` and `Board` classes.

You can use the NI-488.2 class library to create programs that interface with a device that is using GPIB and/or programs that interface with the GPIB device directly.

Tip For information about easily creating a Measurement Studio NI-488.2 application using the Instrument I/O Assistant, refer to the *Creating a Measurement Studio NI-488.2 or NI-VISA Application* section of Chapter 4, *Developing with Measurement Studio*. For more information about GPIB, visit `ni.com/gpib`.

NI-DAQmx

Use the Measurement Studio NI-DAQmx Visual C++ class library to communicate with and control an NI data acquisition (DAQ) device. This class library is included when you install the NI-DAQmx driver.

Note Some DAQ devices are not currently supported by the NI-DAQmx driver. Refer to the *NI-DAQ Readme* for a complete listing of supported hardware.

Use the NI-DAQmx class library to perform the following types of tasks:

- Analog signal measurement
- Analog signal generation
- Digital I/O
- Counting and timing
- Pulse generation
- Signal switching

Tip For information about easily creating an NI-DAQmx application using the DAQ Assistant, refer to the *Creating a Measurement Studio NI-DAQmx Application* or *Walkthrough: Creating a Measurement Studio NI-DAQmx Application* sections of Chapter 4, *Developing with Measurement Studio*. For more information about DAQ, visit `ni.com/dataacquisition`.

NI-Reports

Use the Measurement Studio NI-Reports Visual C++ class library to generate printed reports from Measurement Studio Visual C++ applications. This class library is included only in the Measurement Studio Enterprise package.

Tip For information about generating printed reports using the NI-Reports class library, refer to the *NI-Reports Visual C++ Class Library Overview* topic in the *NI Measurement Studio Help*.

NI-VISA

The Measurement Studio NI-VISA Visual C++ class library includes Visual C++ classes that provide an object-oriented interface to the NI-VISA driver. This class library is included when you install the NI-VISA driver. Use the NI-VISA class library to quickly create bus-independent and/or bus-specific instrument control applications.

The NI-VISA class library supports I/O operations, locking, event handling, and interface-specific extensions. With this class library, you can access the functionality available in NI-VISA for communicating with message-based and register-based instruments using the following interfaces:

- GPIB
- PXI

- Serial (RS-232 and RS-485)
- TCP/IP
- USB
- VXI

Tip For information about easily creating a Measurement Studio NI-VISA application using the Instrument I/O Assistant, refer to the *Creating a Measurement Studio NI-488.2 or NI-VISA Application* or *Walkthrough: Creating a Measurement Studio Instrument I/O Application* sections of Chapter 4, *Developing with Measurement Studio*. For more information about NI-VISA, visit `ni.com/visa`.

User Interface

Use the Measurement Studio User Interface Visual C++ class library to add user interface controls to your application. You can configure the user interface controls programmatically or through the property pages in the Visual C++ resource editor. Measurement Studio includes the following Visual C++ user interface controls:

- Button
- Graph
- Knob
- Numeric edit
- Slide

The following sections describe each of the Measurement Studio user interface controls.

Button Control

Use the Measurement Studio ActiveX button control, as shown in Figure 3-2, for different Boolean displays, such as on/off or true/false. Typically, you use buttons to input or display Boolean information or initiate an action in a program. The `CNiButton` class provides the Visual C++ interface to the ActiveX button control.

Figure 3-2. ActiveX Button Control

With the button control and the classes that interface with the control, you can perform the following operations:

- Configure how the control behaves when you click it with the mouse or press the spacebar when the control has focus.
- Configure how the button control appears using button styles. You can configure the button control to appear as a push button, LED, or switch.
- Bind properties to a DataSocket source or target. You use binding to read property values from a source and write property values to a target.

Tip For more information about easily using the button control, refer to the *Using the Measurement Studio Visual C++ Button Control* section in the *NI Measurement Studio Help*.

Graph Control

Use the Measurement Studio ActiveX graph control, as shown in Figure 3-3, to plot and chart two-dimensional data. The `CNiGraph` class provides the Visual C++ interface to the ActiveX graph control.

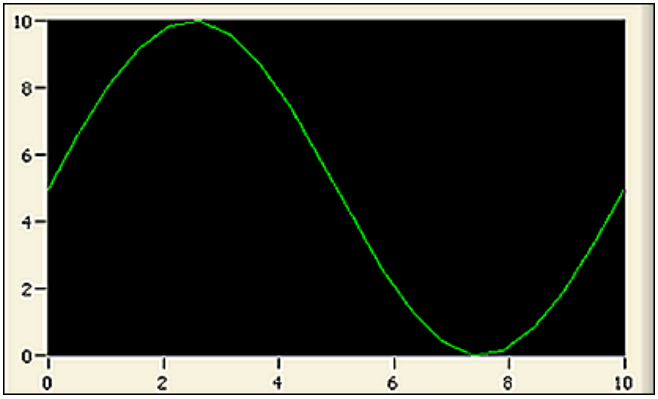


Figure 3-3. ActiveX Graph Control

With the graph control and the classes that interface with the control, you can perform the following operations:

Plot Operations

- Plot and chart data.
- Configure a graph to contain multiple plots to show separate but related data on the same graph.
- Configure a graph to include multiple Y axes so that plot data fits the graph plot area.
- Use cursors and annotations to identify key points in plots and the plot area.

Axis Operations

- Use the `CNiAxis` class to interface to a single axis of a graph control. This feature allows you to modify the appearance and behavior of the axis.
- Automatically label axes with log or inverted numeric scales.
- Configure the axis modes for manual scaling or autoscaling.

Additional Operations

- Configure cursor snap modes to be fixed, floating, nearest point, and to plot.
- Pan and zoom interactively.
- Configure the graph for fixed, strip, or scope charting.
- Customize the graph by using ticks, labels, and value pairs.
- Bind properties to a DataSocket source or target. You use binding to read property values from a source and write property values to a target.

Tip For more information about easily using the graph control, refer to the *Using the Measurement Studio Visual C++ Graph Control* section in the *NI Measurement Studio Help*.

Knob Control

Use the Measurement Studio ActiveX knob control, as shown in Figure 3-4, to display numerical information. The `CNiKnob` class provides the Visual C++ interface to the ActiveX knob control.

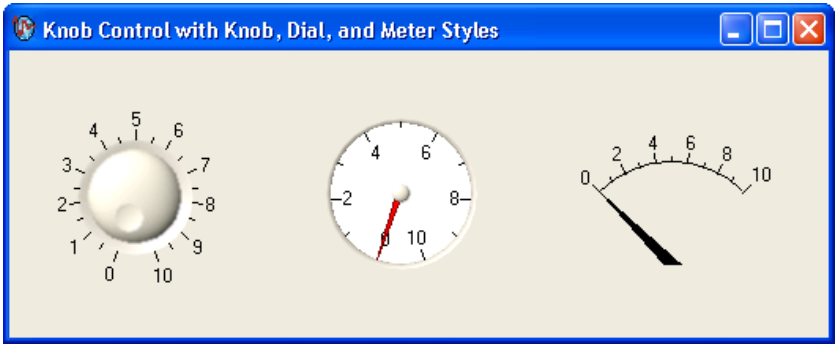


Figure 3-4. ActiveX Knob Control with Knob, Dial, and Meter Styles

With the knob control and the classes that interface with the control, you can perform the following operations:

- Use different display styles—knobs, dials, and meters.
- Use multiple control pointers, each representing one scalar value. A control pointer indicates the current value of the knob.
- Use the `CNiAxis` class to interface to a single axis of a knob control. This feature allows you to modify the appearance and behavior of the axis.

- Automatically label axes with log or inverted numeric scales and continuous or discrete values.
- Customize the knob by using ticks, labels, and value pairs.
- Bind properties to a DataSocket source or target. You use binding to read property values from a source and write property values to a target.

Tip For more information about easily using the knob control, refer to the *Using the Measurement Studio Visual C++ Knob Control* sections in the *NI Measurement Studio Help*.

Numeric Edit Control

Use the Measurement Studio ActiveX numeric edit control, as shown in Figure 3-5, to display numeric values and provide a way by which end users can edit numeric values. Typically, you use a numeric edit control to input or display numerical data instead of using a text box. The `CNiNumEdit` class provides the Visual C++ interface to the ActiveX numeric edit control.

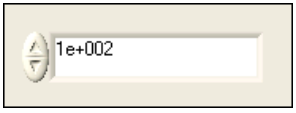


Figure 3-5. ActiveX Numeric Edit Control

With the numeric edit control and the classes that interface with the control, you can perform the following operations:

- Use built-in numeric format styles, including scientific, symbolic engineering, scaling, time, and date.
- Perform range checking.
- Bind properties to a DataSocket source or target. You use binding to read property values from a source and write property values to a target.

Tip For more information about easily using the numeric edit control, refer to the *Using the Measurement Studio Visual C++ Numeric Edit Control* section in the *NI Measurement Studio Help*.

Slide Control

Use the Measurement Studio ActiveX slide control, as shown in Figure 3-6, to display numerical data. `CNiSlide` is the class that provides the Visual C++ interface to the ActiveX slide control.

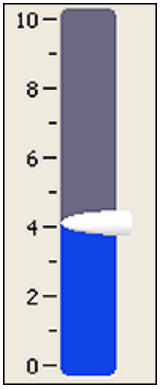


Figure 3-6. ActiveX Slide Control

With the slide control and the classes that interface with the control, you can perform the following operations:

- Use different display styles—vertical, horizontal, tank, and thermometer.
- Use the `CNiAxis` class to interface to a single axis of a slide control. This ability allows you to modify the appearance and behavior of the axis.
- Use multiple control pointers, each one representing one scalar value.
- Automatically label axes with log or inverted numeric scales and continuous or discrete values.
- Customize the slide by using ticks, labels, and value pairs.
- Bind properties to a DataSocket source or target. You use binding to read property values from a source and write property values to a target.

Tip For more information about easily using the slide control, refer to the *Using the Measurement Studio Visual C++ Slide Control* section in the *NI Measurement Studio Help*.

Utility

Use the Measurement Studio Utility Visual C++ class library to easily access Windows operating system functionality. Table 3-2 lists classes in the Utility class library and their functionality.

Table 3-2. Utility Class Names and Functionalities

Utility Class	Functionality
`CNiFile`	`CNiFile` extends the MFC `CStdioFile` class by adding streaming operators for standard Visual C++ data types. In addition, a variety of class static functions add the ability to manipulate file, path, directory, and drive attributes.
`CNiSound`	`CNiSound` encapsulates an interface for generating synchronous and asynchronous tones at specific frequencies.
`CNiSystem`	`CNiSystem` provides the following functionality: • Getting and setting system preferences • Displaying help files • Getting input for the keyboard
`CNiSystemTrayIcon`	`CNiSystemTrayIcon` encapsulates the interface to the system tray area that displays changes in the status of an application. The `CNiSystemTrayIcon` class includes the following features: • Icons—You can place an icon in the system tray to notify the user of changes in an application status. • String tooltips—You can associate a string tooltip with an icon and display the tooltip when the user hovers over the icon. • Shortcut menus—You can associate a shortcut menu with an icon and display the shortcut menu when the user right-clicks the icon. • Overridable event handling.

Table 3-2. Utility Class Names and Functionalities (Continued)

Utility Class	Functionality
`CNiTempFile`	`CNiTempFile` extends the functionality of `CNiFile` to add temporary file creation and manipulation.
`CNiTimer`	`CNiTimer` objects use the Windows multimedia timer to generate high-resolution, asynchronous tick events. Respond to tick events when you want to perform an action at a discrete interval. Additionally, you can count the tick events to calculate elapsed time. The `CNiTimer` class also contains static functions you can use to delay for a period of time or to determine elapsed time between two points in your program.

Tip For more information about using the Utility class library, refer to the *Utility Visual C++ Class Library Overview* section in the *NI Measurement Studio Help*.

4

Developing with Measurement Studio

When you use Measurement Studio in the Visual Studio .NET environment, you have access to measurement and automation tools and features for Visual Basic .NET, Visual C#, and Visual C++. These integrated tools and features are designed to help you quickly and easily build measurement and automation applications.

This chapter includes the following sections to help you develop applications with Measurement Studio:

- *Measurement Studio Menu*
- *Creating a Measurement Studio Project*
- *Walkthrough: Creating a Measurement Studio Application with Windows Forms Controls and Analysis*
- *Creating a Measurement Studio NI-DAQmx Application*
- *Walkthrough: Creating a Measurement Studio NI-DAQmx Application*
- *Creating a Measurement Studio NI-488.2 or NI-VISA Application*
- *Walkthrough: Creating a Measurement Studio Instrument I/O Application*
- *Adding or Removing Measurement Studio Class Libraries*
- *Selecting a Measurement Studio Parameter Value*
- *Calling Instrument Drivers from .NET Languages*

These sections include overview information and step-by-step instructions on developing applications with Measurement Studio tools and features. Refer to the *Developing with Measurement Studio* section and the *Getting Started with the Measurement Studio Class Libraries* section of the *NI Measurement Studio Help* for more information about the functionality of these tools and features.

Measurement Studio Menu

The Measurement Studio Menu provides an easy way to access the following National Instruments resources and tools:

- **Parameter Assistant**—Use the Measurement Studio Parameter Assistant to discover and insert valid parameter values for various Measurement Studio class libraries, such as NI-DAQmx, NI-488.2, and NI-VISA methods.
- **Add/Remove Class Libraries Wizard**—Use the Measurement Studio Add/Remove Class Libraries wizard to add or remove Measurement Studio class libraries or assemblies in existing Visual Basic .NET, Visual C#, or Visual C++ projects.
- **Project Conversion Wizard**—Use the Project Conversion wizard to convert Measurement Studio 1.0 and 6.0 Visual C++ projects to the current version installed on your machine.
- **National Instruments Tools»Measurement & Automation Explorer (MAX)**—Use MAX to configure NI hardware; add new channels, interfaces, and virtual channels; execute system diagnostics; and view devices and instruments connected to the system.
- **National Instruments Tools»NI Spy**—Use NI Spy to monitor, record, and display National Instruments API calls made by instrument connectivity applications. Use NI Spy to quickly locate and analyze any erroneous National Instruments API calls that an application makes and verify that the communication with an instrument is correct.
- **Discussion Forums**—Use NI Discussion Forums at `forums.ni.com` to participate in discussion forums and exchange code with measurement and automation developers around the world.
- **Instrument Driver Network**—Use the NI Instrument Driver Network at `ni.com/idnet` as a central resource for downloading, developing, and submitting instrument drivers.
- **Search Technical Support**—Use NI Technical Support at `ni.com/support` to find support resources available for most products, including software drivers and updates, KnowledgeBase articles, product manuals, step-by-step troubleshooting wizards, conformity documentation, example code, tutorials and application notes, instrument drivers, discussion forums, and a measurement glossary.

- **NI Measurement Studio Help**—Use the *NI Measurement Studio Help* to access detailed Measurement Studio help, including function reference, walkthroughs, and conceptual topic documentation on developing with Measurement Studio.
- **Additional Online Resources»Measurement Studio Home Page**—Use the Measurement Studio Web site at `ni.com/mstudio` to find Measurement Studio news, support, downloads, and evaluation software.
- **Additional Online Resources»Measurement Encyclopedia**—Use the online NI Measurement Encyclopedia to find information on measurement principles, standards organizations, and a wide range of technology and measurement terms.
- **Preferences**—Use the Measurement Studio Preferences dialog box to configure Measurement Studio settings, such as conversion options and add-in preferences.
- **Patents**—Use the Patents dialog box to view information about NI patents.
- **About NI Measurement Studio**—Use the NI Measurement Studio About box to view version information.

Tip For more information about the resources included in the Measurement Studio Menu, refer to the *Measurement Studio Menu* topic in the *NI Measurement Studio Help*.

Creating a Measurement Studio Project

Measurement Studio includes class library and application templates that you can use to quickly create measurement applications with Visual Basic .NET, Visual C#, and Visual C++. Refer to the following section, *Walkthrough: Creating an Application with Windows Forms Controls and Analysis*, for step-by-step instructions on how to create a Measurement Studio project. Use the Visual Studio .NET New Project dialog box, as shown in Figure 4-1, to access these templates and create the following types of projects:

- Measurement Studio Visual Basic .NET project
- Measurement Studio Visual C# project
- Measurement Studio Visual C++ project
- Measurement Studio Visual C++ project with LabWindows/CVI libraries

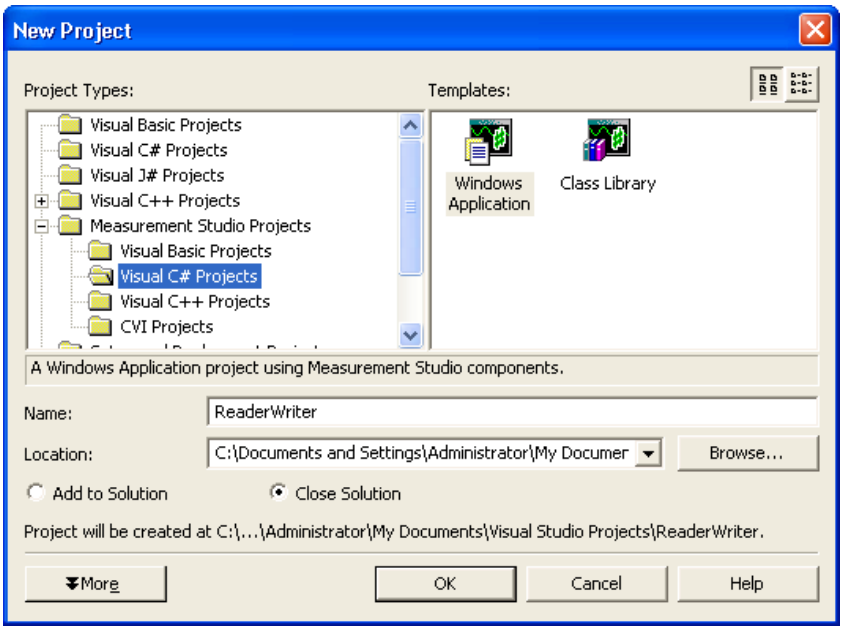


Figure 4-1. New Project dialog box

Tip For more information about using project templates to create a new Measurement Studio project, refer to the *Creating a New Measurement Studio Project* section in the *NI Measurement Studio Help*. For information about converting Measurement Studio projects, refer to the *Converting Measurement Studio Projects* section in the *NI Measurement Studio Help*.

Adding or Removing Measurement Studio Class Libraries

To add or remove Measurement Studio class libraries from a project, use the Measurement Studio Add/Remove Class Libraries wizard on the Measurement Studio menu. This wizard provides an interface, as shown in Figure 4-2, that you can use to select the Measurement Studio class libraries you want to add to or remove from a project.

When you exit the wizard, the wizard adds or removes the appropriate references to or from the project, thus adding or removing the functionality associated with the class library.

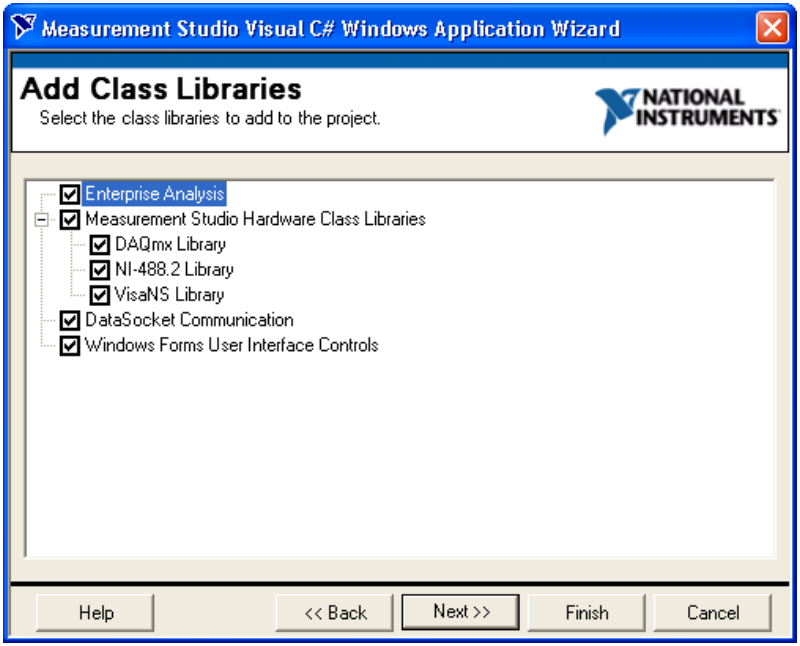


Figure 4-2. Measurement Studio Add/Remove Class Libraries Wizard

Tip For more information about using the Add/Remove Class Libraries wizard to add or remove Measurement Studio class libraries, refer to the *Adding or Removing Measurement Studio Class Libraries* section in the *NI Measurement Studio Help*.

Walkthrough: Creating a Measurement Studio Application with Windows Forms Controls and Analysis

Measurement Studio includes user interface controls, such as a waveform graph control and a gauge control, and Analysis functionality such as signal generation and mathematical functions. This walkthrough is designed to help you learn how to add analysis and presentation functionality to a Windows Forms application by taking you through the following steps:

- **Setting up the project**—Using the Measurement Studio Application Wizard, you will create a new project that references the Measurement Studio Analysis class library and Windows Forms controls.
- **Adding user interface controls to the project**—Using the Toolbox and the Properties window, you will add and configure user interface controls, including a button, waveform graph, legend, gauge, and numeric edit.

- **Generating, plotting, and analyzing the data**—Using `NationalInstruments.Analysis.SignalGeneration.WhiteNoiseSignal` and `NationalInstruments.Analysis.Math.Statistics.Mean`, you will generate data, plot the generated data on a waveform graph, and calculate the mean of the data.
- **Customizing the user interface**—Using the Collection Editor and Auto Format dialog boxes, you will display the mean value on the gauge and the numeric edit, as well as customize your user interface.

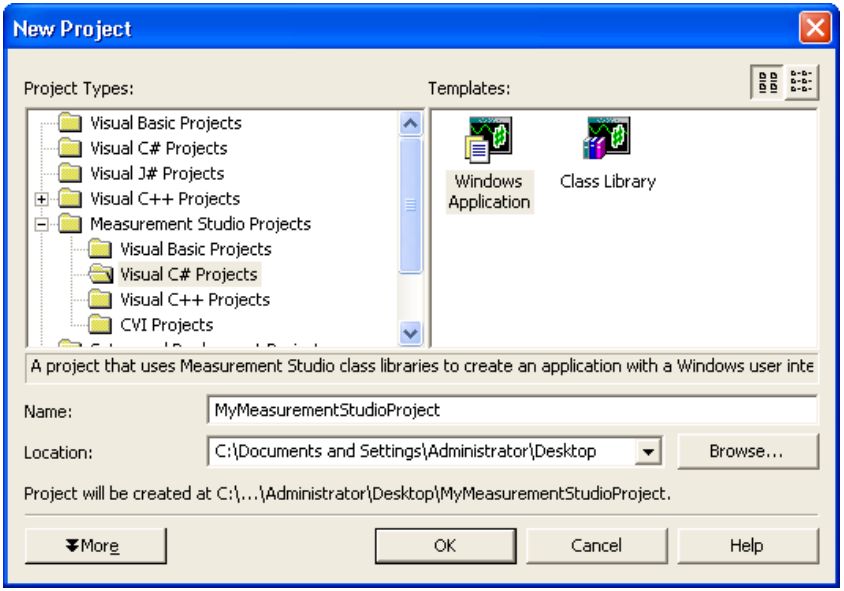
Before You Begin

The following components are required to complete this walkthrough:

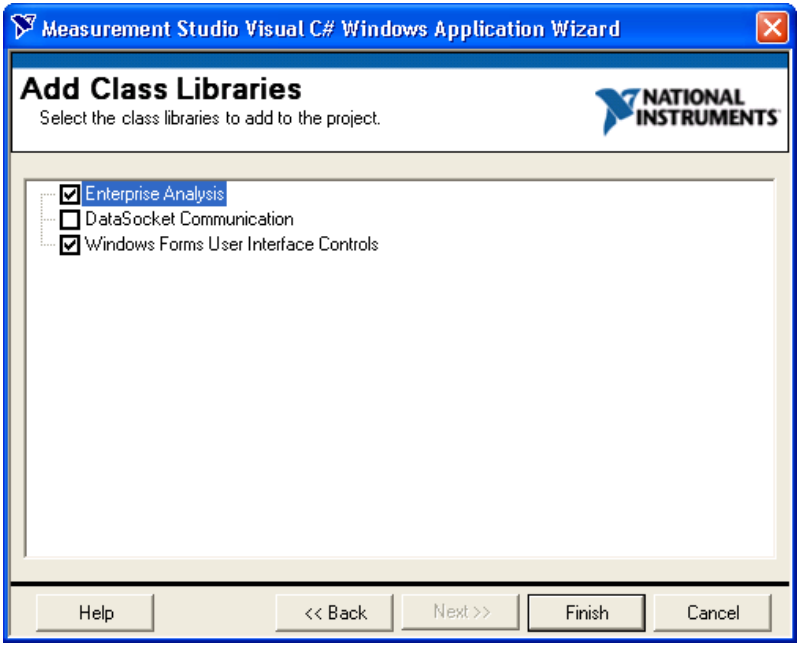
- Microsoft Visual Studio .NET 2003
- Measurement Studio 8.0 (Professional or Enterprise package)

Setting up the project

1. Select **Start»All Programs»Microsoft Visual Studio .NET 2003»Microsoft Visual Studio .NET 2003**.
2. Select **File»New»Project**. The New Project dialog box launches.



3. In the Project Types pane, expand the **Measurement Studio Projects** folder. Select **Visual Basic Projects** or **Visual C# Projects**, depending on which language you want to create the project in.
4. In the Templates pane, select **Windows Application**. Specify `MyMeasurementStudioProject` for **Name** and specify a **Location** of your choice.
5. Click **OK**. The Measurement Studio Application Wizard launches.
6. Select **Analysis** and **Windows Forms User Interface Controls**.



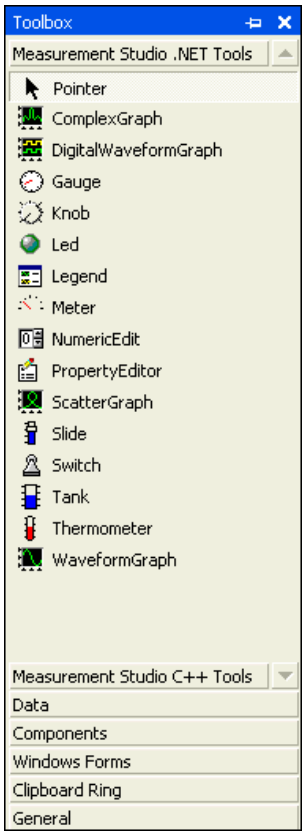
Tip If you are working with an existing project, you can access the Add Class Libraries dialog box by selecting **Measurement Studio»Add/Remove Class Libraries Wizard**.

7. Click **Finish** to display `Form1` in the Windows Forms Designer.

Adding user interface controls to the project

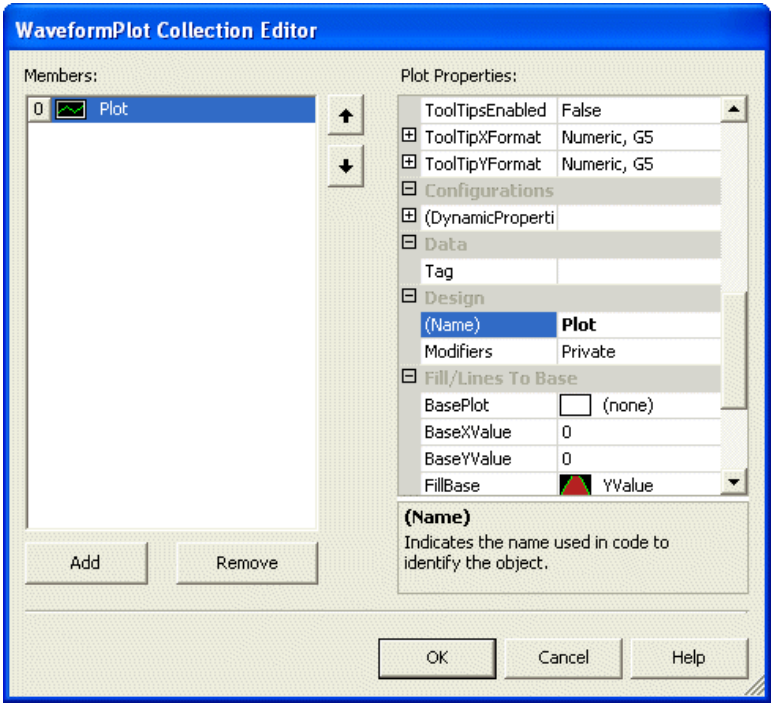
1. Select **View»Toolbox** to display the Toolbox. The toolbox contains components and controls that you can add to your project.
2. Select the **Windows Forms** tab. The Windows Forms tab contains controls and components included in the `System.Windows.Forms` namespace.

3. Select the **Button** control and drag and drop it onto the form.
4. Right-click the button and select **Properties** to display the Properties window. You configure the properties of the control in the Properties window.
5. The Text property will be highlighted. Type `Start` for the button text.
6. Select the **Measurement Studio .NET Tools** tab on the Toolbox.



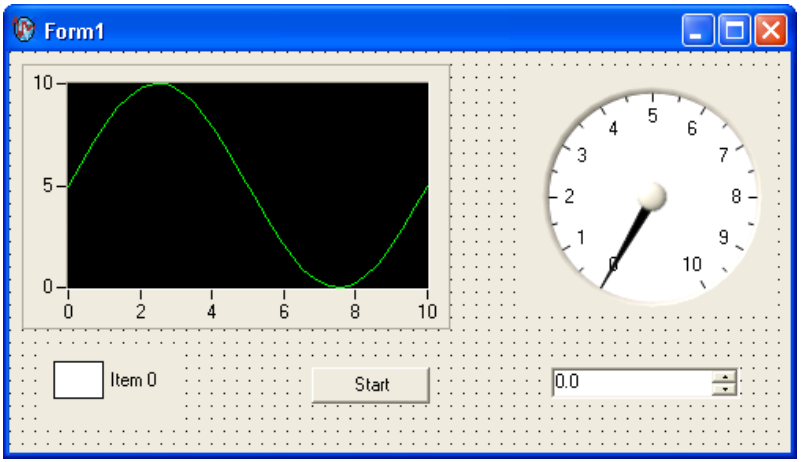
7. Select the **WaveformGraph** control and drag and drop it onto the form.

8. Right-click the waveform graph and select **Edit Plots** to display the WaveformPlot Collection Editor dialog box. You use the WaveformPlot Collection Editor dialog box to add or remove plots and to configure plot properties.



9. Type `Plot` for the Name. Click **OK**.
10. Before you add the legend and gauge controls, you need to resize the form to accommodate them. Select the form and use the double-sided arrow to resize it.
11. Select the **Legend** control and drag and drop it onto the form.
12. Select the **NumericEdit** control and drag and drop it onto the form.
13. Select the **Gauge** control and drag and drop it onto the form.
14. Right-click the gauge and select **Properties** to display the Properties window.
15. Type `gauge` for the name of the gauge.

The following screenshot shows `Form1` with the user controls.



Generating, plotting, and analyzing the data

1. Double-click the button control to display the `Form1` code, with the cursor inside the click event handler of the button control.
2. Add the following code to generate random data, plot the data, calculate the mean of the data, and display the mean on the gauge.

[VB.NET]

```
' Declare and initialize an instance of WhiteNoiseSignal.
Dim whiteNoise As New WhiteNoiseSignal()
' Store the generated data in a double array named data.
Dim data As Double() = whiteNoise.Generate(1000.0, 256)
' Use the PlotY method to plot the data.
Plot.PlotY(data)
' Use the Mean method to calculate the mean of the data.
Dim mean As Double = Statistics.Mean(data)
' Display the mean on the gauge.
gauge.Value = mean
```

[C#]

```
// Declare and initialize an instance of WhiteNoiseSignal.
WhiteNoiseSignal whiteNoise = new WhiteNoiseSignal();

// Store the generated data in a double array named data.
double[] data = whiteNoise.Generate(1000.0, 256);
```

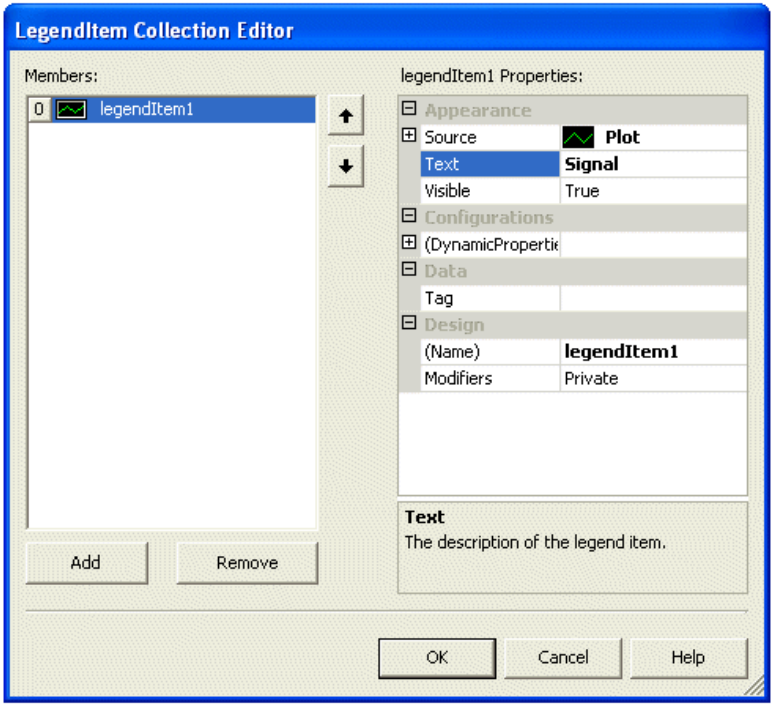
```
// Use the PlotY method to plot the data.
Plot.PlotY(data);

// Use the Mean method to calculate the mean of the data.
double mean = Statistics.Mean(data);

// Display the mean on the gauge.
gauge.Value = mean;
```

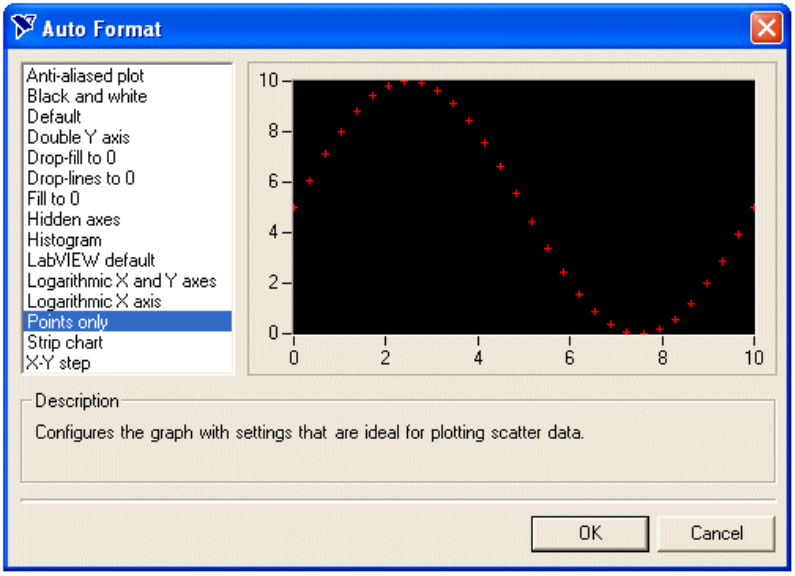
Customizing your user interface

1. Right-click the legend and select **Edit Items** to display the LegendItem Collection Editor dialog box. You use the LegendItem Collection Editor dialog box to add or remove legend items and to configure legend item properties.



2. Select **Plot** in the **Source** drop-down list and enter `Signal` in the **Text** box. Click **OK**. Now that you have specified a legend item for the plot, changes you make to the plot will be reflected on the legend.

3. Right-click the graph and select **Auto Format** to display the Auto Format dialog box. The Auto Format dialog box provides a set of pre-configured control styles. When you select a style and click **OK**, the Auto Format feature configures the appropriate control properties to reflect the style you chose.
4. Select **Points Only**. Click **OK**. Notice that the legend changed automatically to match the formatting of the graph.

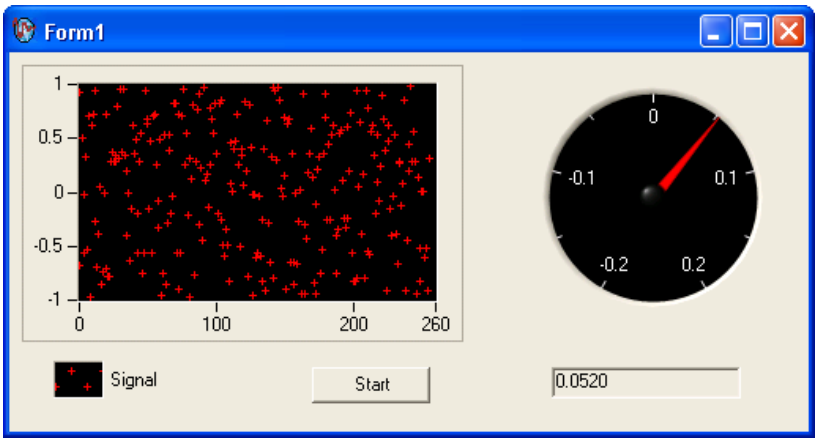


5. Right-click the gauge and select **Auto Format** to display the Auto Format dialog box.
6. Select **Dark** and click **OK**.
7. Right-click the gauge and select **Properties** to display the Properties window.
8. Set the Range property for the gauge with the drop-down Range type editor. Type `-0.2` for the minimum value and type `0.2` for the maximum value.
9. Right-click the numeric edit and select **Properties** to display the Properties window.
10. Select **Gauge** in the **Source** drop-down list. Setting the Source property to the gauge allows two-way binding between the controls.
11. Deselect **ArrowKeys**, **Buttons**, and **Text** for the **InteractionMode** property of the numeric edit control. Deselecting these interaction

modes makes the numeric edit an indicator. The numeric edit control only displays the calculated mean.

12. Select the Format Mode property and in the Numeric Edit Format Mode Editor dialog box, change the Precision to `4`. Click **OK**.
13. Select **File»Save Form1.cs** to save your application.
14. Select **Debug»Start Without Debugging** to run the application.
15. After your program builds, click **Start**. Notice the graph shows the data plot, and the gauge and the numeric edit display the mean of the data.

The following screenshot shows `Form1` with customization.



Creating a Measurement Studio NI-DAQmx Application

To create a Measurement Studio NI-DAQmx application, use the DAQ Assistant. The DAQ Assistant integrates into Visual Studio .NET as a code designer. Use the Add New Item wizard to add an NI-DAQmx task to your project, and use the DAQ Assistant user interface, as shown in Figure 4-3, to interactively create and configure the NI-DAQmx task. The DAQ Assistant automatically generates a Visual Basic .NET, Visual C#, or Visual C++ class that includes the functionality you configure in the user interface. Refer to the following section, *Walkthrough: Creating a Measurement Studio NI-DAQmx Application*, for step-by-step instructions on how to use the DAQ Assistant.

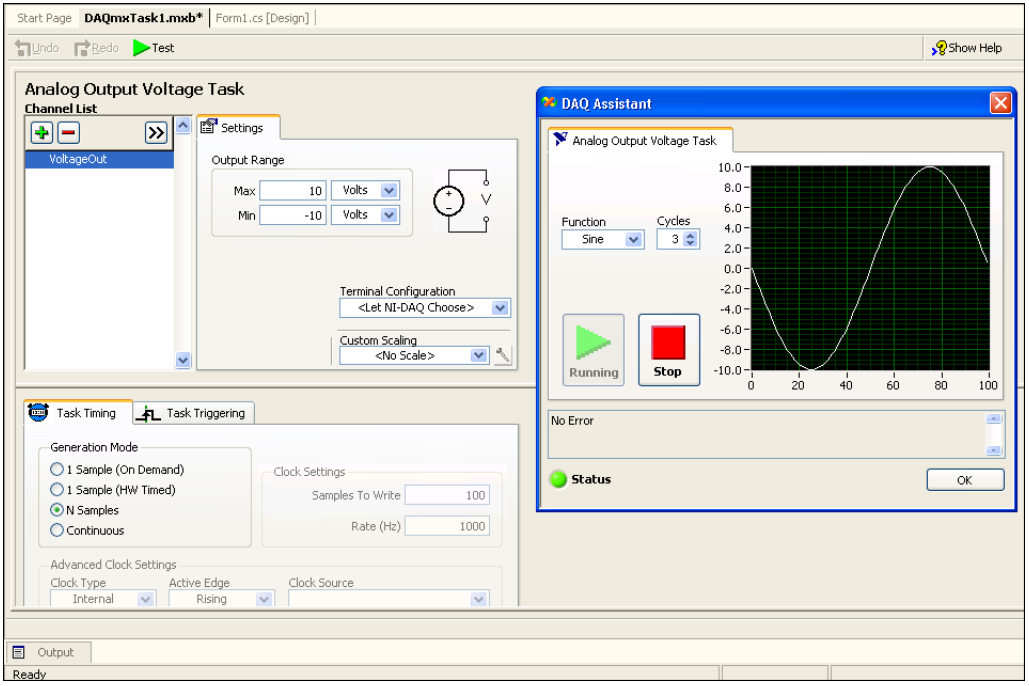


Figure 4-3. DAQ Assistant

The DAQ Assistant interactively assists you in performing the following operations:

- Creating an NI-DAQmx task class
- Configuring an NI-DAQmx task class
- Generating a Visual Basic .NET, Visual C#, or Visual C++ class that includes the functionality you configure in the user interface
- Generating code that uses an NI-DAQmx task class
- Using an NI-DAQmx task class in a project

Tip For more information about using the DAQ Assistant to create a Measurement Studio NI-DAQmx application, refer to the *Creating a Measurement Studio NI-DAQmx Application* section in the *NI Measurement Studio Help*.

Creating an NI-DAQmx User Control

You can create an NI-DAQmx .NET user control with Measurement Studio that provides a default graphical user interface to an NI-DAQmx task. The NI-DAQmx User Control wizard wraps a configured NI-DAQmx task class in a user-friendly control. You can drop the generated user control from the Visual Studio .NET Toolbox onto a form and use it just as you use any Windows Forms control.

Tip For more information on how to create a user control, refer to the *Using a DAQmx Task Class in a Project* topic in the *NI Measurement Studio Help*.

Walkthrough: Creating a Measurement Studio NI-DAQmx Application

This walkthrough is designed to help you learn how to create an NI-DAQmx application by taking you through the following steps:

- **Setting up the project**—Using the Measurement Studio Application Wizard, you will create a new project that references the NI-DAQmx assembly and launches the DAQ Assistant to create an NI-DAQmx task.
- **Configuring your task**—Using the DAQ Assistant, you will interactively configure and save your task. The wizard then generates code to reflect your configuration settings.
- **Creating a custom UI control and source code for the task**—Using the Add New Item wizard, you will create a custom NI-DAQmx user control that uses the task you just configured to automatically plot the DAQ signal.
- **Acquiring data**—To begin acquiring data from the DAQ device or simulated device, you will drop the custom UI control onto a form and run your application. The DAQ signal automatically begins plotting data onto your control.

Before You Begin

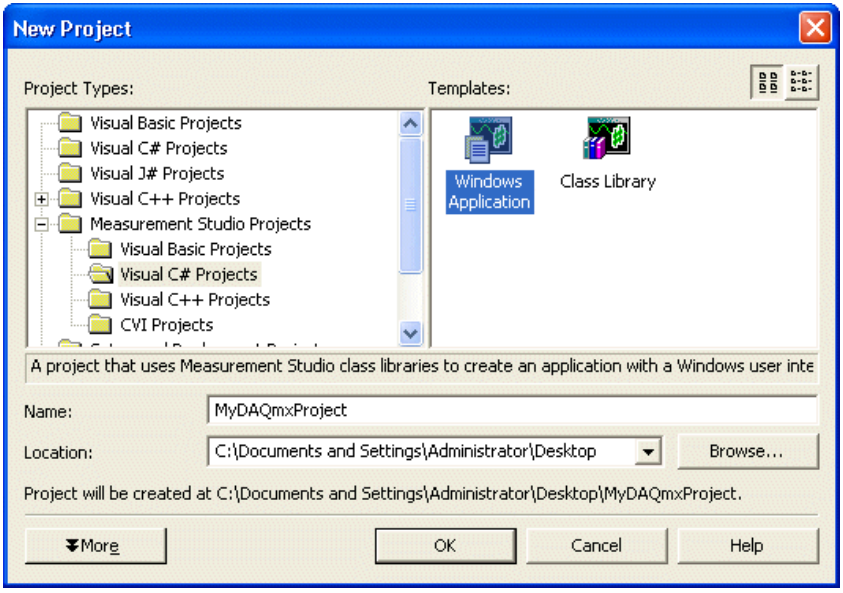
The following components are required to complete this walkthrough:

- Visual Studio .NET 2003
- Measurement Studio 8.0 (Professional or Enterprise package)
- NI-DAQmx 7.4 or later
- NI-DAQmx-supported DAQ device or simulated device

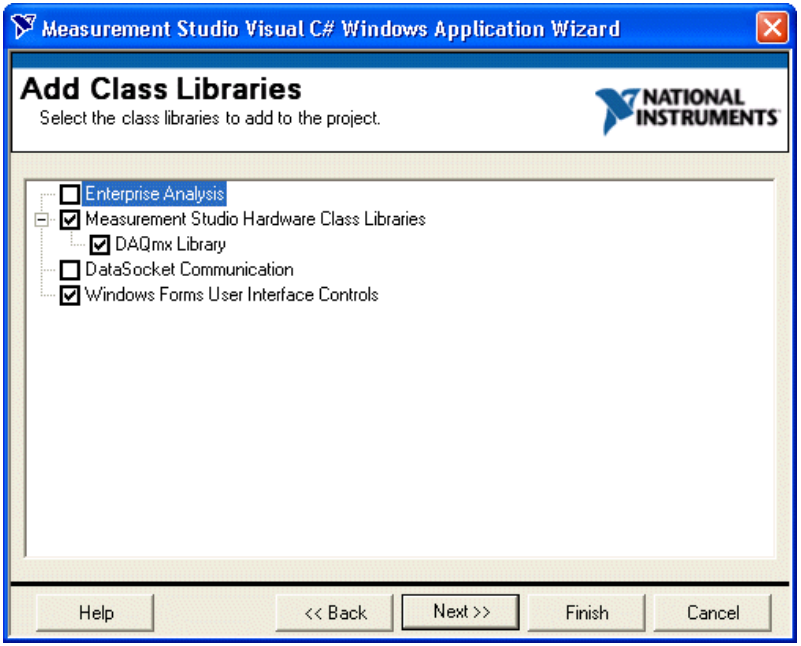
For information about installing and configuring your DAQ device, refer to the *DAQ Quick Start Guide*. You can also use simulation to complete this walkthrough. For information on how to create an NI-DAQmx simulated device, refer to *Creating NI-DAQmx Simulated Devices* in the *Measurement & Automation Explorer Help for NI-DAQmx*. To open this help, select **Start»All Programs»National Instruments»Measurement & Automation**. In Measurement & Automation Explorer (MAX), select **Help»Help Topics»NI-DAQmx»MAX Help for NI-DAQmx**. For the purposes of this walkthrough, the NI PCI-6280 device of the M Series DAQ family is recommended.

To set up the project

1. Open Visual Studio .NET from **Start»All Programs»Microsoft Visual Studio .NET 2003»Microsoft Visual Studio .NET 2003**.
2. Select **File»New»Project**. The New Project dialog box launches.
3. In the Project Types pane, expand the **Measurement Studio Projects** folder. Select **Visual Basic Projects** or **Visual C# Projects**, depending on which language you want to create the project in. Code generation works in both languages.
4. In the Templates pane, select **Windows Application**. Specify `MyDAQmxProject` for **Name** and specify a **Location** of your choice. Click **OK**. The Measurement Studio Application Wizard launches.

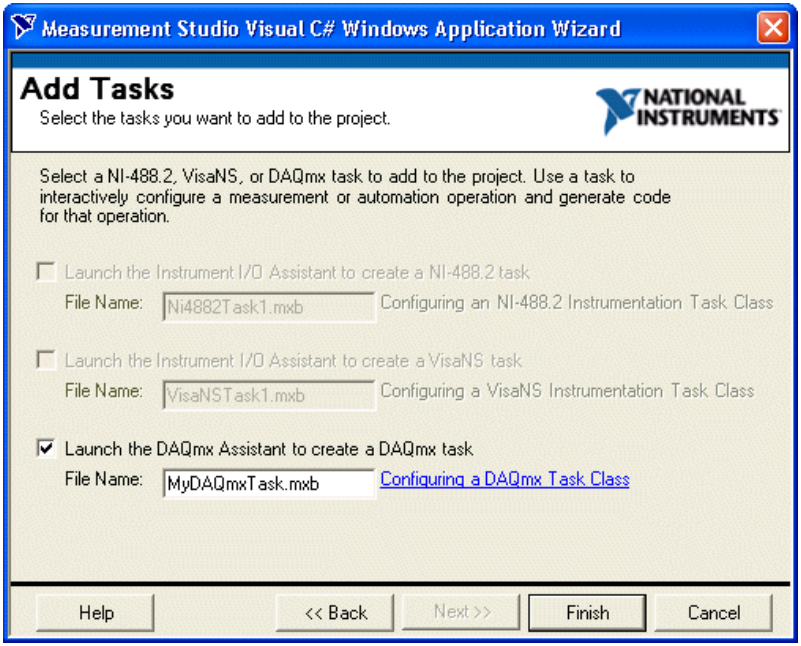


5. In the Add Class Libraries dialog box, ensure that **DAQmx Library** and **Windows Forms Controls** are selected. When you select these libraries, the Measurement Studio Application Wizard automatically adds references to the appropriate class libraries. Click **Next**.

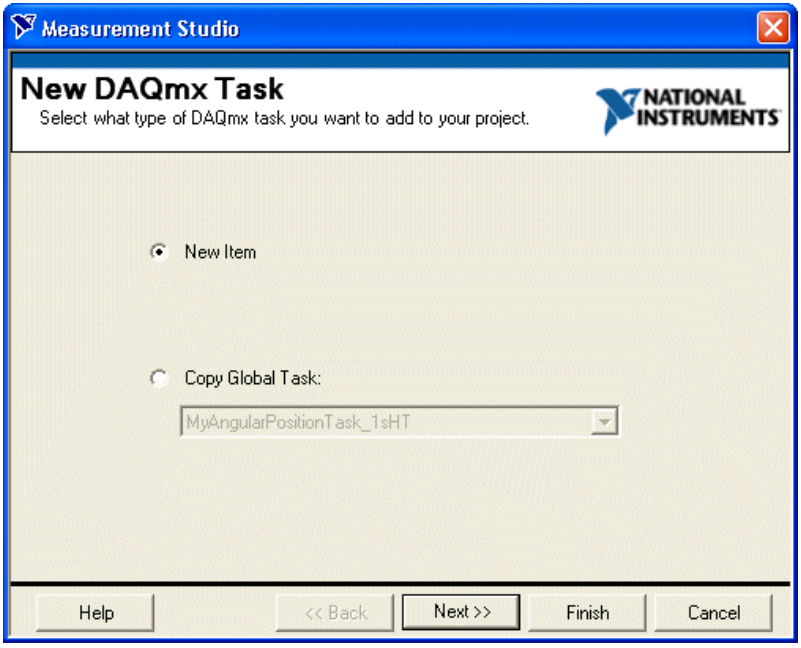


Tip If you are working with an existing project, you can access the Add Class Libraries dialog box by selecting **Measurement Studio»Add/Remove Class Libraries Wizard**.

6. In the Add Tasks dialog box, you can configure the Measurement Studio Application Wizard to add a task to your project using the DAQ Assistant. Select **Launch the DAQmx Assistant to create a DAQmx task** and specify `MyDAQmxTask.mxb` for the **File Name**. This file name is the name used for the class that is generated later in this walkthrough. For more information, click the **Configuring a DAQmx Task Class** link to access the help. Click **Finish**.


Measurement Studio Visual C# Windows Application Wizard
Add Tasks
Select the tasks you want to add to the project.
NATIONAL INSTRUMENTS
Select a NI-488.2, VisaNS, or DAQmx task to add to the project. Use a task to interactively configure a measurement or automation operation and generate code for that operation.
Launch the Instrument I/O Assistant to create a NI-488.2 task
File Name: Ni4882Task1.mxb
Configuring an NI-488.2 Instrumentation Task Class
Launch the Instrument I/O Assistant to create a VisaNS task
File Name: VisaNSTask1.mxb
Configuring a VisaNS Instrumentation Task Class
Launch the DAQmx Assistant to create a DAQmx task
File Name: MyDAQmxTask.mxb
Configuring a DAQmx Task Class
Help
<< Back
Next >>
Finish
Cancel

7. The Measurement Studio Application Wizard automatically sets up your data acquisition project and launches the DAQmx Task Wizard.
8. In the New DAQmx Task dialog box, you can choose either to create a new task or copy a global task that was created in MAX. For more information, refer to *Creating an NI-DAQmx Task from an Existing Task in MAX*. For this walkthrough, select **New Item** and click **Next**.

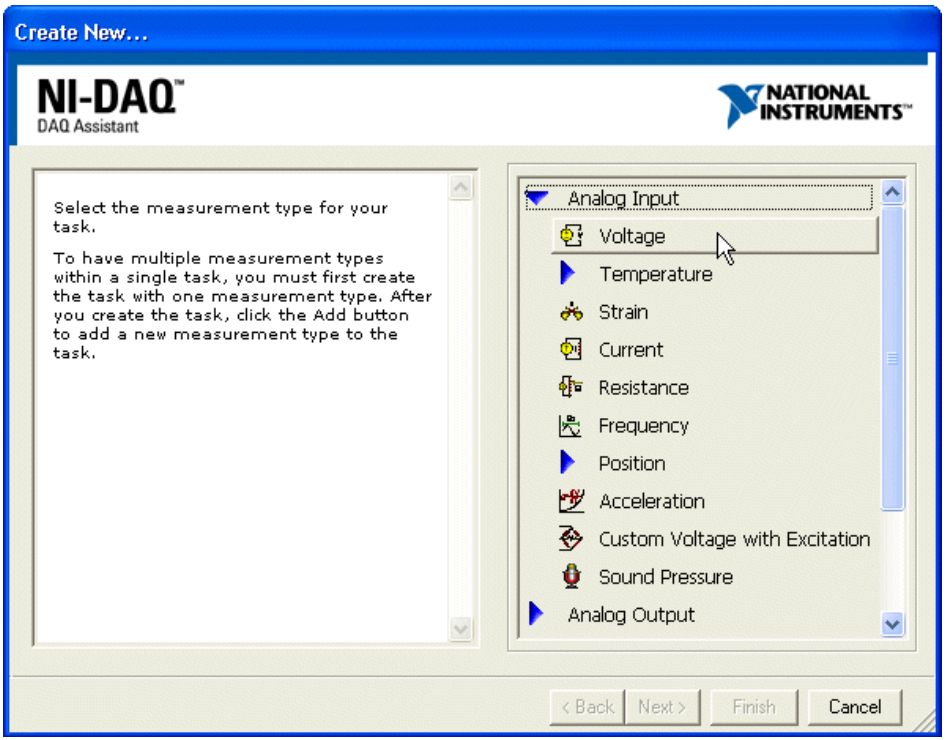


Tip If you are working with an existing project, you can access the New DAQmx Task dialog box by selecting **Project»Add New Item**.

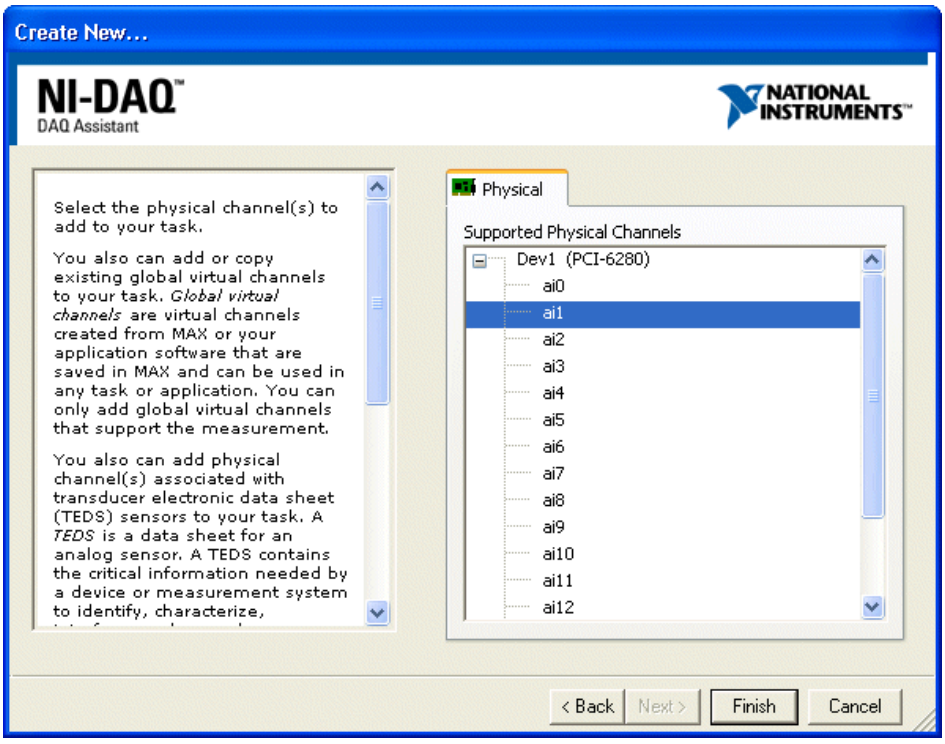
9. Review the information in the New DAQmx Task Summary dialog box and click **Finish**. The DAQ Assistant launches, starting with the Create New dialog box.

To configure your task

1. In the Create New dialog box of the DAQ Assistant, you can begin to interactively define your DAQ task. Select **Analog Input** as the measurement type for your task.
2. Next, select **Voltage**.



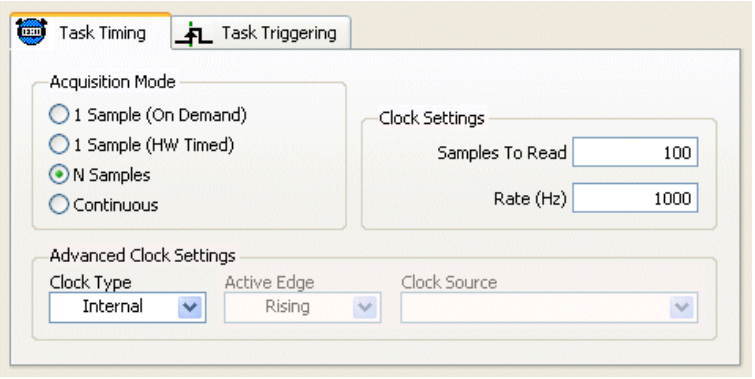
3. In **Supported Physical Channels**, select the physical channel, such as **ai1**, on the DAQ device to which you connected the voltage signal. Click **Finish**.


Create New...
NI-DAQ
DAQ Assistant
NATIONAL INSTRUMENTS
Select the physical channel(s) to add to your task.
You also can add or copy existing global virtual channels to your task. Global virtual channels are virtual channels created from MAX or your application software that are saved in MAX and can be used in any task or application. You can only add global virtual channels that support the measurement.
You also can add physical channel(s) associated with transducer electronic data sheet (TEDS) sensors to your task. A TEDS is a data sheet for an analog sensor. A TEDS contains the critical information needed by a device or measurement system to identify, characterize,
Physical
Supported Physical Channels
Dev1 (PCI-6280)
ai0
ai1
ai2
ai3
ai4
ai5
ai6
ai7
ai8
ai9
ai10
ai11
ai12
< Back
Next >
Finish
Cancel

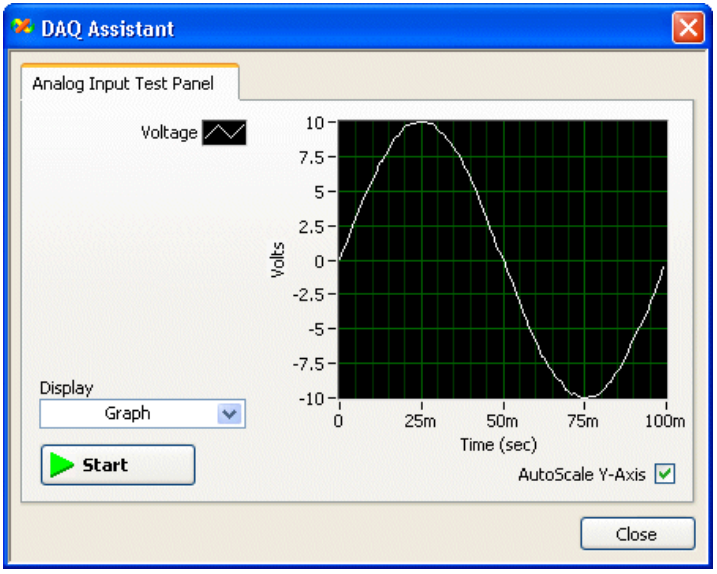
Note You can also use simulation in this walkthrough. For more information, refer to *Creating NI-DAQmx Simulated Devices* in the *Measurement & Automation Explorer Help for NI-DAQmx*.

4. After the DAQ Assistant configuration window opens within the Visual Studio environment, select the **MyDAQmxTask.mxb** tab. If the embedded DAQ Assistant help is not open by default, click the **Show Help** button in the upper-right corner of the window to display the help.

5. To complete the DAQ configuration, select the **N Samples** Acquisition Mode in the **Task Timing** tab. For more information on timing, refer to *Timing* in the *NI-DAQmx Help*.

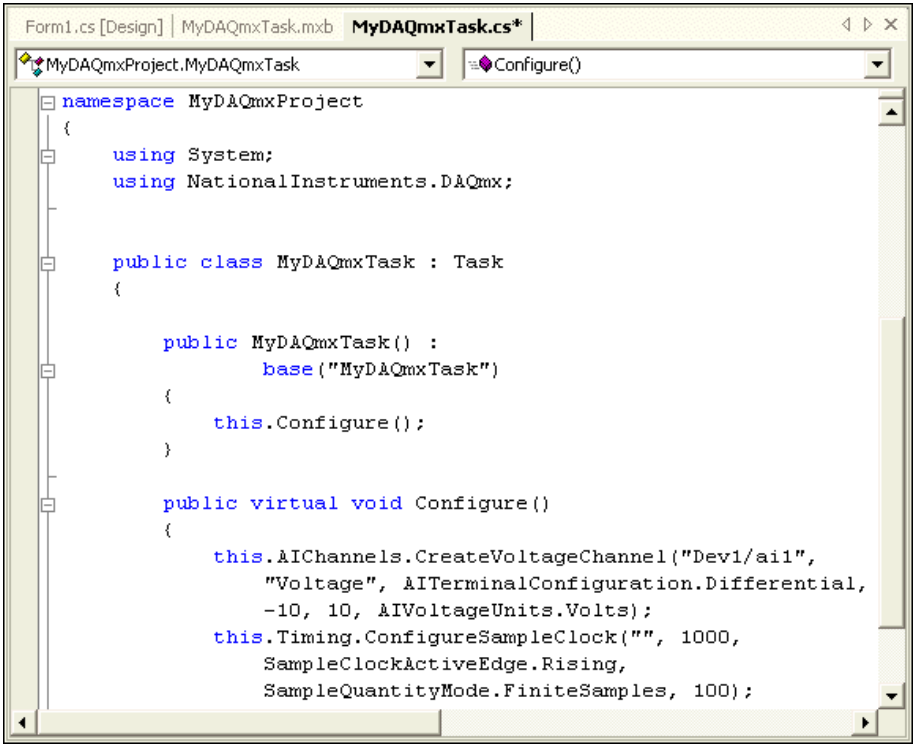


6. Next, click the **Test** button to launch the test panel for your task. The test runs automatically. You can use test panels in the DAQ Assistant to test the task and make sure you connected the signal properly. If necessary, you can modify the settings before any code is generated.



7. Click the **Close** button when you are done.

8. Right-click the **MyDAQmxTask.mxb** tab and select **Save MyDAQmxTask.mxb**. Saving the `.mxb` file causes the DAQ Assistant to regenerate the class so that any changes you made are automatically reflected.
9. The class contains source code that corresponds to the configuration information that is stored in the `.mxb` file. To view this code, right-click the `.mxb` file in the Solution Explorer and select **View Code**. If the Solution Explorer is not open, select **View»Solution Explorer**.

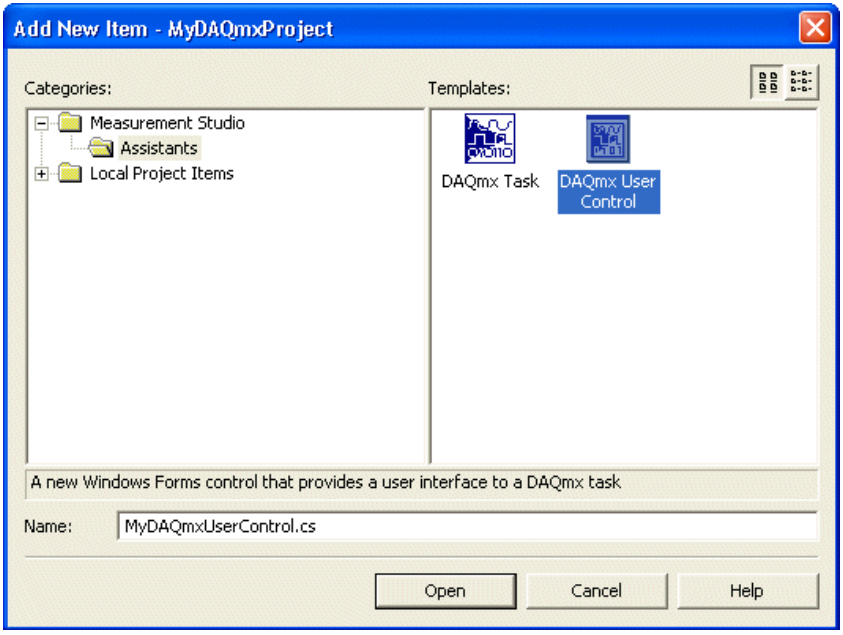


10. Notice that the call to `ConfigureSampleClock` has a sample mode set to finite. This mode is what you selected in the previous step 5. For more information on this step, refer to *Generating Code for a DAQmx Task Class* in the *NI Measurement Studio Help*.

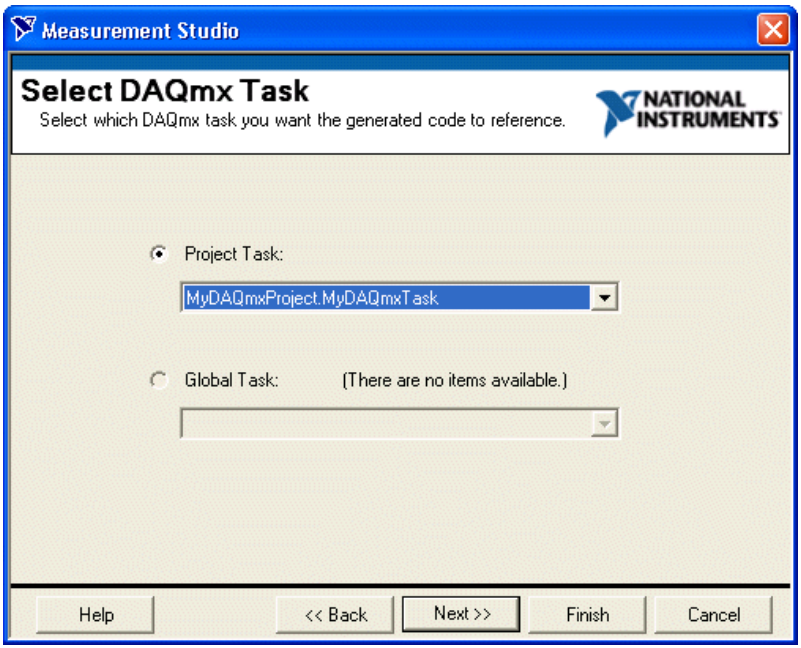
Your NI-DAQmx task is now configured and ready to use in a project.

To create a custom UI control and source code for the task

1. Select **Project»Add New Item**. The Add New Item dialog box launches.
2. In the Categories pane of the Add New Item dialog box, expand the **Measurement Studio** folder and select **Assistants**.
3. In the Templates pane, select **DAQmx User Control**. Specify `MyDAQmxUserControl` for **Name** and click **Open**.



4. In the Select DAQmx Task dialog box, select **Project Task** and then select **MyDAQmxProject.MyDAQmxTask** from the drop-down menu. This binds the NI-DAQmx user control with the task that you just created. A project task is used for classes that are created using the DAQ Assistant from Visual Studio. A global task is a task that is created and saved in MAX. For more information, refer to *Creating Tasks and Channels* in the *Measurement & Automation Explorer Help for NI-DAQmx*. Click **Next**.



5. Review the information in the New DAQmx Task Summary and click **Finish**.

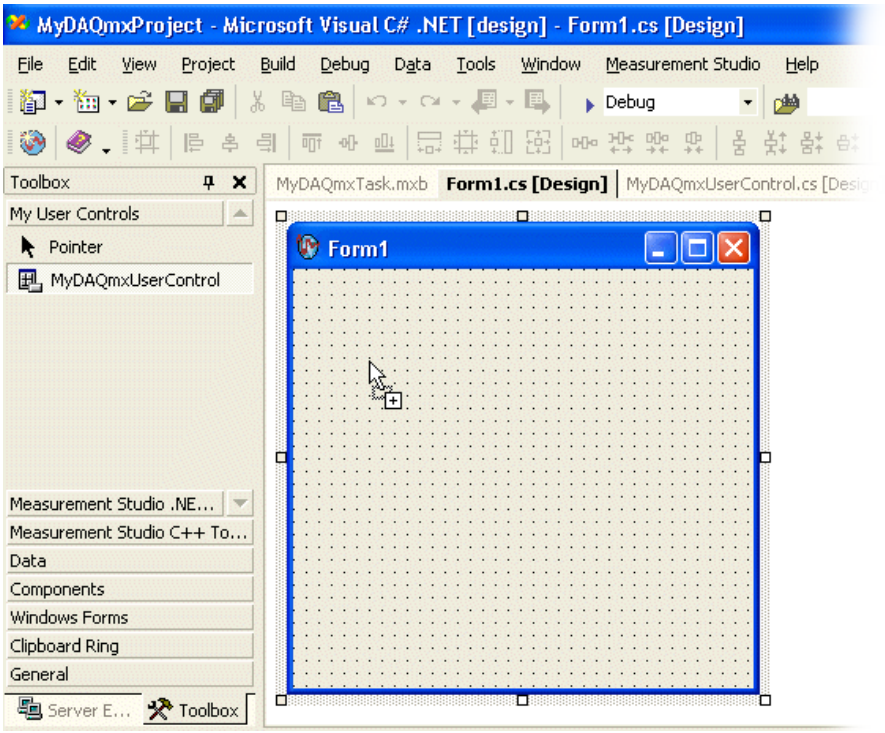
   Measurement Studio generates and adds a class named `MyDAQmxUserControl` to your project. A new user control is placed in the **My User Controls** tab of the Visual Studio toolbox and opened in the Windows Forms Designer. The user control is designed to be used either as a user interface element, or if a user interface is not needed, to be directly called from source code.

6. Right-click **MyDAQmxUserControl.cs** in the Solution Explorer and select **View Code**. Browse through the code that is opened in the **MyDAQmxUserControl.cs** tab. Notice that, in addition to providing a custom UI for the task, the DAQ Assistant has generated all the source code needed to run your task, including the `CreateTask`, `CleanupTask`, and `Read` methods.

7. Select **Build»Build Solution** to build the solution so that the environment can recognize the control. This step is a requirement of user controls in Visual Studio.

To acquire data

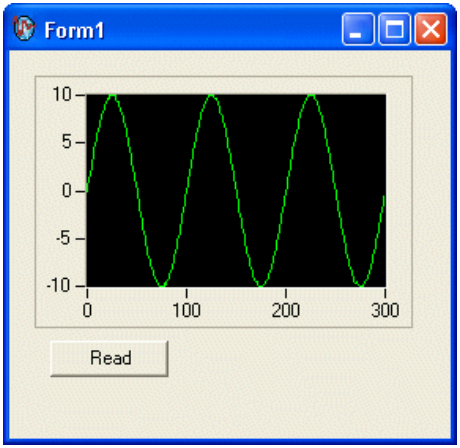
1. Select the **Form1.cs[Design]** tab so that you can place UI controls on the form.
2. In the Visual Studio .NET Toolbox, select **MyDAQmxUserControl** from the **My User Controls** tab, and drag it to `Form1`.



Tip If you receive a user control error message when you drop the MyDAQmxUserControl on `Form1`, ensure that you have first compiled the project by selecting **Build»Build Solution**.

3. Select **Debug»Start Without Debugging** to run the application.

4. After you have started the application, click the **Read** button to begin acquiring data from your DAQ device.



What's Next

To learn more about tasks, channels, and other NI-DAQmx concepts, refer to the *NI-DAQmx Help* located at **Start»All Programs»National Instruments»NI-DAQ»NI-DAQmx Help**.

For more information about creating and using tasks in Measurement Studio, refer to *Using the Measurement Studio NI-DAQmx .NET Library* in the *NI Measurement Studio Help*.

You can also look at examples that ship with NI-DAQmx. Refer to *Measurement Studio NI-DAQmx .NET Examples* in the *NI Measurement Studio Help* for the locations of these examples.

Creating a Measurement Studio NI-488.2 or NI-VISA Application

To create a Measurement Studio NI-488.2 or NI-VISA application, use the Instrument I/O Assistant. The Instrument I/O Assistant, as shown in Figure 4-4, integrates into Visual Studio .NET as a code designer. Use the Add New Item wizard to add an instrumentation task to your project, and use the Instrument I/O Assistant user interface to create and configure the instrumentation task. The Instrument I/O Assistant generates a Visual Basic .NET, Visual C#, or Visual C++ class that includes the functionality you configure in the user interface. Use this assistant to help you write code that

communicates with devices such as serial, Ethernet, or GPIB instruments. Refer to the following section, *Walkthrough: Creating a Measurement Studio Instrument I/O Application*, for step-by-step instructions on how to use the Instrument I/O Assistant.

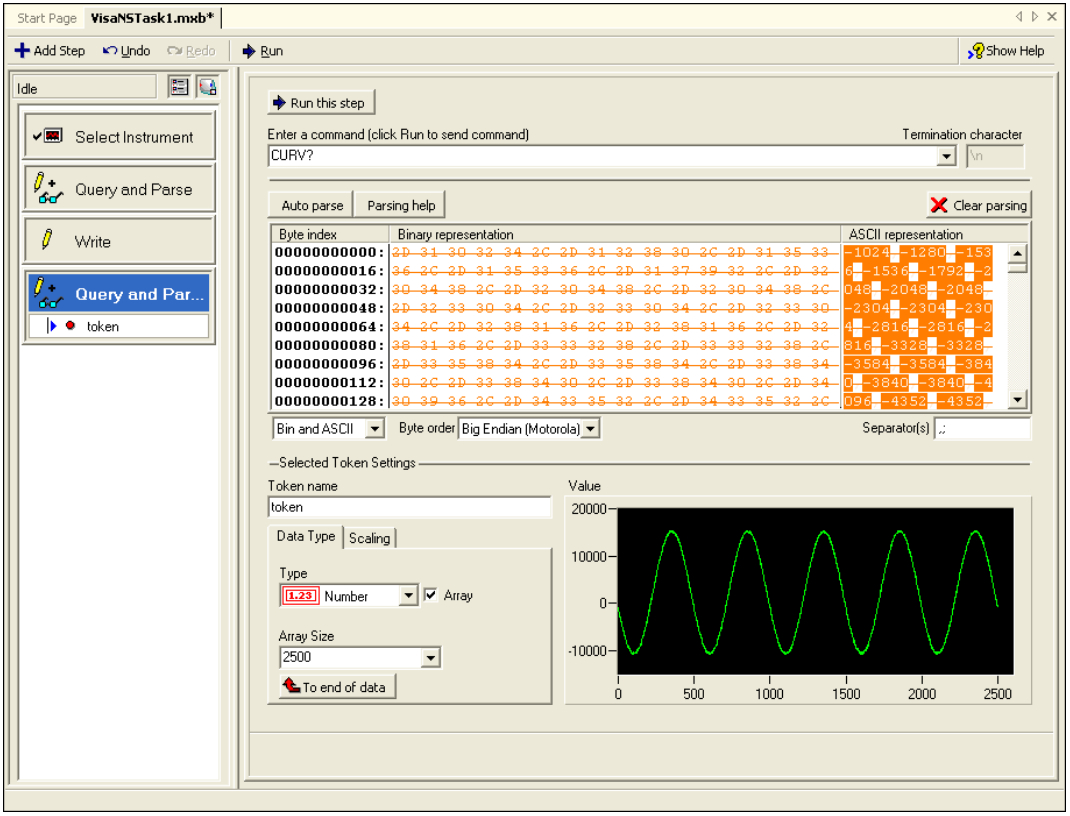


Figure 4-4. Instrument I/O Assistant

The Instrument I/O Assistant aids you in performing the following operations:

- Creating an instrumentation task class.
- Configuring an instrumentation task class to communicate with an instrument and parse data you receive from the instrument.

Tip For more information about using the Instrument I/O Assistant to create a Measurement Studio NI-488.2 or NI-VISA application, refer to the *Creating a Measurement Studio 488.2 or VISA Application* section of the *NI Measurement Studio Help*.

Walkthrough: Creating a Measurement Studio Instrument I/O Application

The National Instruments Instrument I/O Assistant organizes instrument communication for a serial, Ethernet, or GPIB instrument into ordered steps. This walkthrough is designed to help you learn how to build an instrument I/O application by taking you through the following steps:

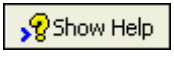
- **Setting up the project**—Using the Measurement Studio Application Wizard, you will create a new project that references the VisaNS assembly and launches the Instrument I/O Assistant to create a VisaNS task.
- **Performing a query on the instrument**—Using the Instrument I/O Assistant, you will write a command to an instrument and read the instrument response.
- **Displaying Instrument I/O Assistant data on your UI**—Using text box and button controls, you will create a Windows Forms application to display the Instrument I/O Assistant data.

Before You Begin

The following components are required to complete this walkthrough:

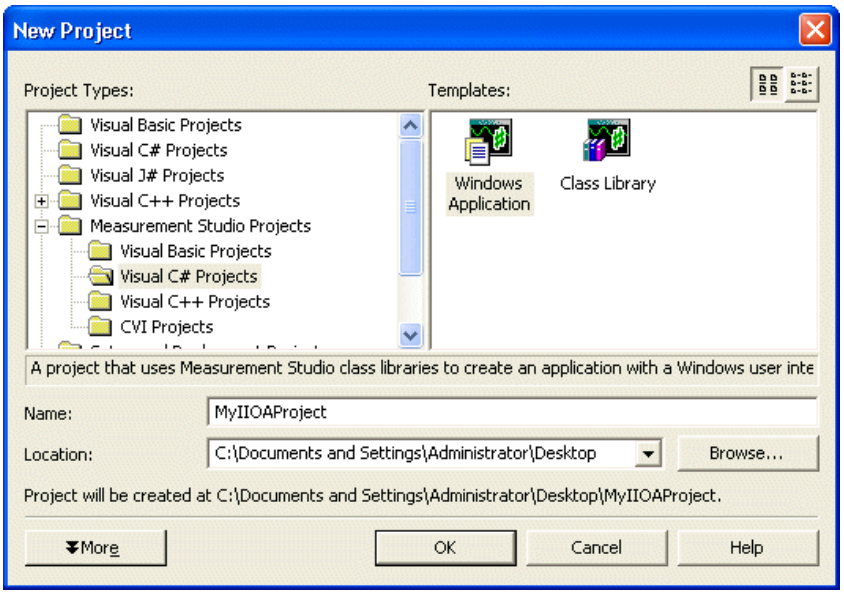
- Visual Studio .NET 2003
- Measurement Studio 8.0 (Professional or Enterprise package)
- National Instruments Device Driver CD
- Message-based instrument on a supported VISA bus, such as GPIB or Serial

Note For more information about the Instrument I/O Assistant, refer to the *Instrument I/O Assistant Help* by selecting the **Show Help** button inside the assistant.



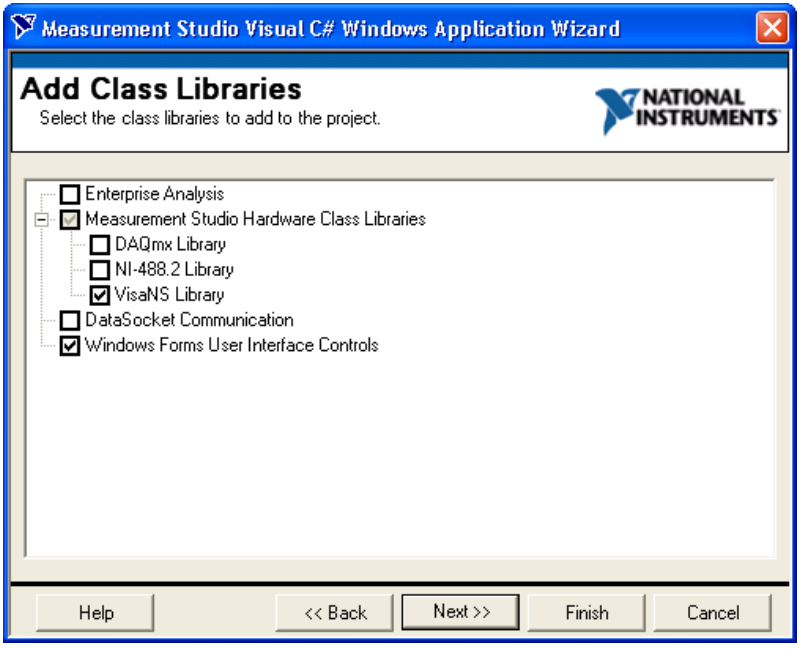
Setting up the project

1. Open Visual Studio .NET from **Start»All Programs»Microsoft Visual Studio .NET 2003»Microsoft Visual Studio .NET 2003**.
2. Select **File»New»Project**. The New Project dialog box launches.



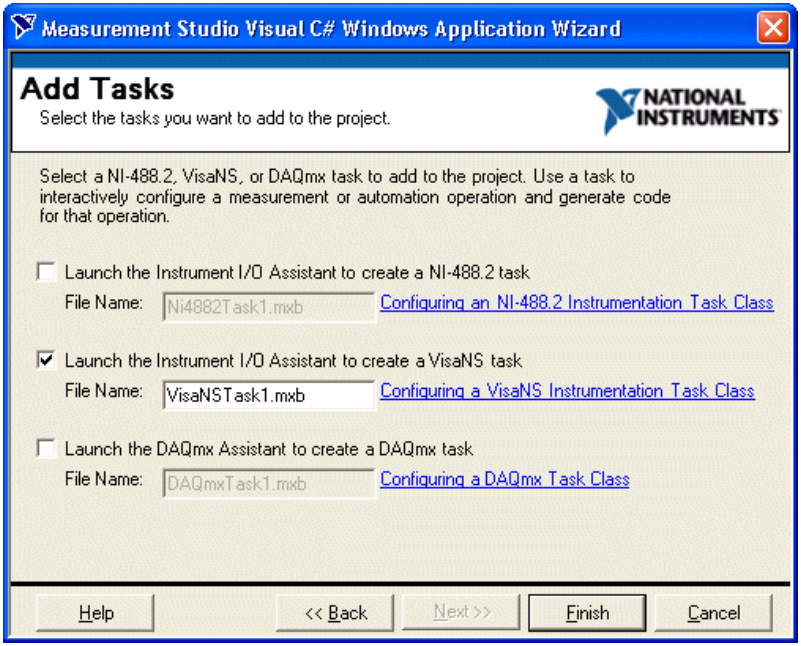
3. In the Project Types pane, expand the **Measurement Studio Projects** folder. Select **Visual Basic Projects** or **Visual C# Projects**, depending on which language you want to create the project in. This walkthrough refers to Visual C#, but Visual Basic .NET users can follow the same process.
4. In the Templates pane, select **Windows Application**. Specify `MyIIOAProject` for **Name** and select a **Location** of your choice.

5. Click **OK**. The Measurement Studio Application Wizard launches.



Tip If you are working with an existing project, you can access the Add Class Libraries dialog box by selecting **Measurement Studio»Add/Remove Class Libraries Wizard**.

6. In the Application Wizard dialog box, select **Windows Forms User Interface Controls** and **VisaNS Library**. The wizard automatically adds references to the appropriate class libraries and sets up the project for you.
7. Click **Next**.
8. Select **Launch the Instrument I/O Assistant to create a VisaNS Task**. This option adds a new Instrument I/O Assistant task to your project. Each task consists of a collection of related instrument communication operations that you want your application to perform together. For more information, click the **Configuring a VisaNS Instrumentation Task Class** link to access the help.


Measurement Studio Visual C# Windows Application Wizard
Add Tasks
Select the tasks you want to add to the project.
NATIONAL INSTRUMENTS
Select a NI-488.2, VisaNS, or DAQmx task to add to the project. Use a task to interactively configure a measurement or automation operation and generate code for that operation.
Launch the Instrument I/O Assistant to create a NI-488.2 task
File Name: Ni4882Task1.mxb
Configuring an NI-488.2 Instrumentation Task Class
Launch the Instrument I/O Assistant to create a VisaNS task
File Name: VisaNSTask1.mxb
Configuring a VisaNS Instrumentation Task Class
Launch the DAQmx Assistant to create a DAQmx task
File Name: DAQmxTask1.mxb
Configuring a DAQmx Task Class
Help
<< Back
Next >>
Finish
Cancel

Tip If you are working with an existing project, you can access the Add Tasks dialog box by selecting **Project»Add New Item**.

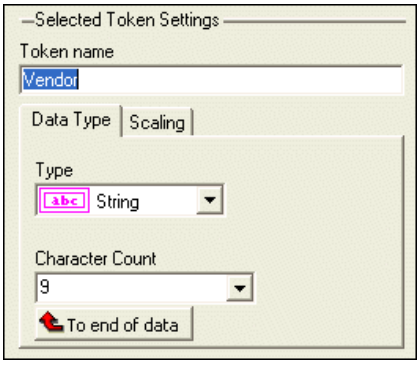
9. Click **Finish**. The Instrument I/O Assistant automatically launches.

Performing a query on the instrument

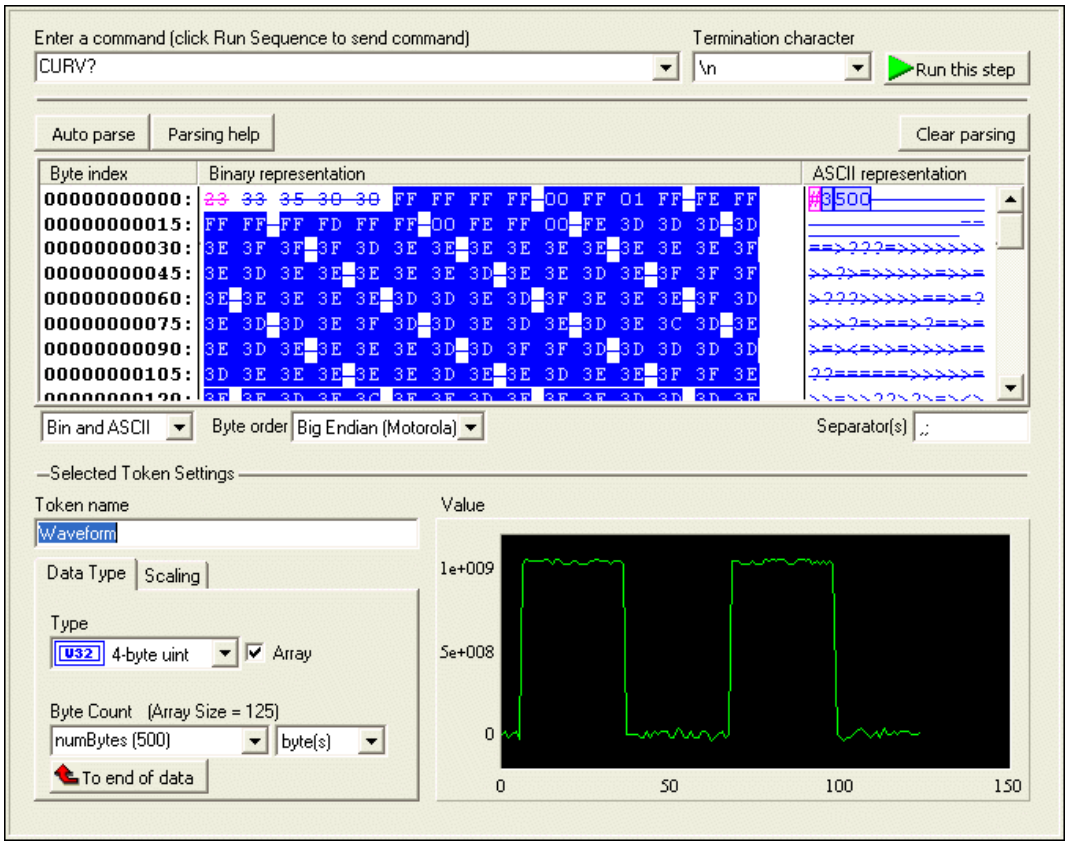
1. The **Select Instrument** step automatically appears in the **Step Sequence** window when you launch the Instrument I/O Assistant. Select the instrument you want to communicate with or the port your instrument is connected to from the **Select an instrument** drop-down listbox.
2. Select **Add Step** and then select **Query and Parse** from the expanded list. You use a Query and Parse step to write a command to an instrument and to read the instrument response at once.

3. Enter the command `*idn?` and click **Run this step**. The `*idn?` command is a standard instrument command for querying an instrument's identification information. If your instrument does not support the `*idn?` command, refer to the documentation for the instrument for more information about the instrument's command set.

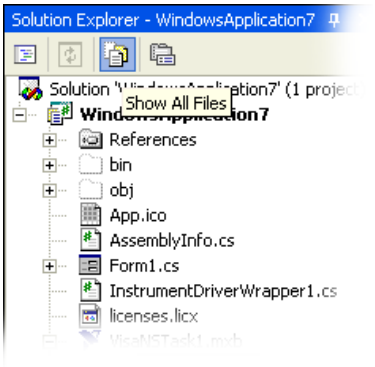
4. Click **Auto parse** to parse the instrument's response. The **Auto parse** button automatically parses binary block data and ASCII text. Refer to the *Parsing an Instrument Response* topic in the *Instrument I/O Assistant Help* for information about how the Assistant parses different data formats.
5. If there are more than two tokens in the token list, remove them for this example. To remove a token, right-click on it in the Response window and select **Remove**.
6. Click **Token**. In the **Token name** text box, enter `Vendor` to rename the first token. You use this name to reference the token in your application.



7. Rename **Token2** to `Device`.
8. Select **File»Save** to save your task.



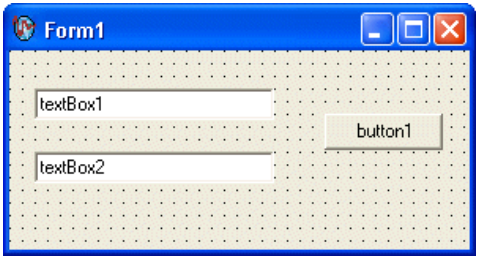
9. Select **View»Solution Explorer** to display the Solution Explorer.
10. Click the **Show All Files** icon.



11. Double-click the `VisaNSTask1.cs` file to view the code that the Instrument I/O Assistant generated for you.

Displaying Instrument I/O Assistant data on your user interface

1. Double-click to open `Form1.cs`.
2. Select **View»Toolbox** to display the Toolbox.
3. Select the **WindowsForms** tab on the Toolbox.
4. Select the **Button** control and drag and drop it onto the form.
5. Select the **TextBox** control and drag and drop it onto the form. Repeat this step to add a second text box to the form. The following screenshot shows the controls on the form:



6. Double-click the **Button** control to display the `Form1` code, with the cursor inside the click event handler of the button control.

7. Add the following code to display the vendor and model name of your instrument in the text boxes:

[VB.NET]

```
' Declare variable values for vendor and model
Dim vendor, model As String
' Declare an instance of VisaNSTask
Dim mytask As New VisaNSTask1()
' Display the data in the text boxes
mytask.Run(vendor, model)
textBox1.Text = vendor
textBox2.Text = model
```

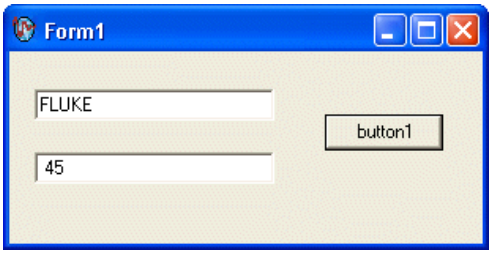
[C#]

```
{
    // Declare variable values for vendor and model
    string vendor, model;

    // Declare an instance of VisaNSTask
    VisaNSTask1 mytask = new VisaNSTask1();

    // Display the data in the text boxes
    mytask.Run (out vendor, out model);
    textBox1.Text = vendor;
    textBox2.Text = model;
}
```

8. Select **Debug»Start Without Debugging** to run the application.
9. Click the **button** on the form to run the task. The following screenshot shows the controls on the form, with sample returned data.



Note Although this walkthrough only covers the use of a simple **Query and Parse** step, the Instrument I/O Assistant offers additional features, such as independent **Write** and **Read and Parse** steps and advanced parsing capabilities. The following screenshot shows the IIOA's ability to scale and parse IEEE 488.2 Definite Length block data.

Selecting a Measurement Studio Parameter Value

To access I/O devices or resources, you must specify string constants or scalar values for many method parameters and property values. Use the Measurement Studio Parameter Assistant, on the Measurement Studio menu, to discover and insert into your code valid parameter values for methods and various Measurement Studio class libraries, such as NI-DAQmx, NI-488.2, and NI-VISA.

With the Parameter Assistant, you can select the correct parameter value for a device or resource, as shown in Figure 4-5, based on your current system configuration. Click the **Insert Selected Item** button on the Parameter Assistant to insert the value into the current location in the active source file.

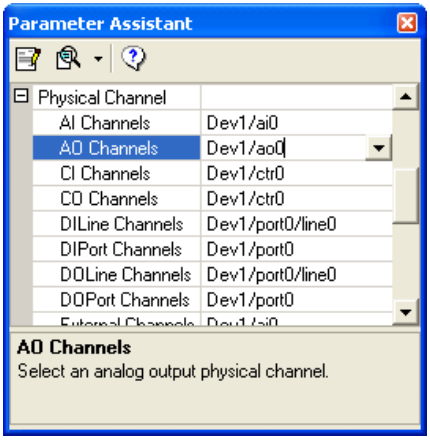


Figure 4-5. Measurement Studio Parameter Assistant

Tip For information about using the Measurement Studio Parameter Assistant to select a parameter value, refer to the *Selecting a Measurement Studio Parameter Value* section in the *NI Measurement Studio Help*.

Calling Instrument Drivers from .NET Languages

To use an IVI or VXI *plug&play* instrument driver with a C DLL in a Measurement Studio .NET application, use the Measurement Studio .NET Instrument Driver wizard to create .NET entry points to the C DLL functions you need to call from your application. Use the Add New Item wizard to select the .NET Instrument Driver Wizard.

The Measurement Studio .NET Instrument Driver wizard, as shown in Figure 4-6, generates a .NET wrapper class for calling into IVI, VXI *plug&play*, and legacy instrument drivers based on the instrument driver function panel, header file, and an optional `.sub` file for IVI drivers. The wizard can generate both Visual C# and Visual Basic .NET source code. After completing the wizard, a new instrument driver wrapper class is added to your project and opened in the source code editor.

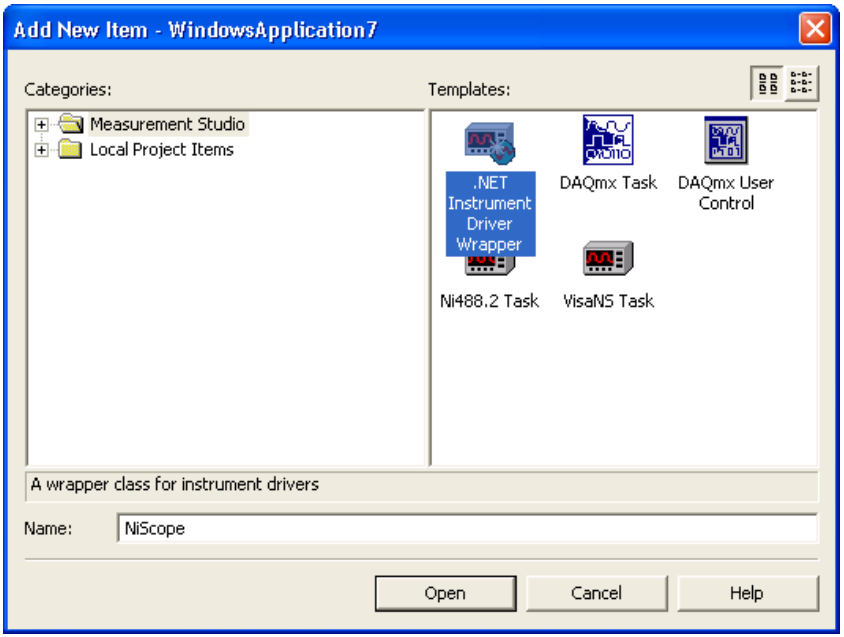


Figure 4-6. Launching the Measurement Studio .NET Instrument Driver Wizard from the Add New Item Wizard

Tip For information about the .NET instrument driver wizard, refer to the *Using Instrument Drivers in Measurement Studio Applications* section in the *NI Measurement Studio Help*.

A

Technical Support and Professional Services

Visit the following sections of the National Instruments Web site at ni.com for technical support and professional services:

- **Support**—Online technical support resources at ni.com/support include the following:
  - **Self-Help Resources**—For answers and solutions, visit the award-winning National Instruments Web site for software drivers and updates, a searchable KnowledgeBase, product manuals, step-by-step troubleshooting wizards, thousands of example programs, tutorials, application notes, instrument drivers, and so on.
  - **Free Technical Support**—All registered users receive free Basic Service, which includes access to hundreds of Application Engineers worldwide in the NI Developer Exchange at ni.com/exchange. National Instruments Application Engineers make sure every question receives an answer.

    For information about other technical support options in your area, visit ni.com/services or contact your local office at ni.com/contact.
- **Training and Certification**—Visit ni.com/training for self-paced training, eLearning virtual classrooms, interactive CDs, and Certification program information. You also can register for instructor-led, hands-on courses at locations around the world.
- **System Integration**—If you have time constraints, limited in-house technical resources, or other project challenges, National Instruments Alliance Partner members can help. To learn more, call your local NI office or visit ni.com/alliance.

If you searched ni.com and could not find the answers you need, contact your local office or NI corporate headquarters. Phone numbers for our worldwide offices are listed at the front of this manual. You also can visit the Worldwide Offices section of ni.com/niglobal to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

Glossary

A

ActiveX	Set of Microsoft technologies for reusable software components. Formerly called OLE.
ActiveX control	Reusable software component that adds functionality to any ActiveX control container through exposed properties, methods, and events. The Measurement Studio data acquisition, user interface, and analysis controls are examples of ActiveX controls.
ActiveX control container	Development environment that fully supports ActiveX controls and integrates them into its own environment using COM. An ActiveX control container enables you to specify how ActiveX controls interact with the environment through environment properties. Visual Basic is an example of an ActiveX control container.
analog I/O	Reading or writing data in continuously variable physical quantities, such as voltage or current.
annotate	Adding text, arrows, or shapes to describe or highlight a point or region on a graph.
ANSI C	C programming language defined by the American National Standards Institute.
API	Application Programming Interface. A specification of software functions and their input and return parameters.
assembly	A collection of one or more files that are versioned and deployed as a unit. An assembly is the primary building block of a .NET Framework application. All managed types and resources are contained within an assembly and are marked either as accessible only within the assembly or as accessible from code in other assemblies.
asynchronous	Function that begins an operation and returns control to the program prior to the completion or termination of the operation.

B

button — A control used to input or display Boolean information or to initiate an action in a program.

C

channel — 1. Physical—a terminal or pin at which you can measure or generate an analog or digital signal. A single physical channel can include more than one terminal, as in the case of a differential analog input channel or a digital port of eight lines. The name used for a counter physical channel is an exception because that physical channel name is not the name of the terminal where the counter measures or generates the digital signal.

2. Virtual—a collection of property settings that can include a name, a physical channel, input terminal connections, the type of measurement or generation, and scaling information. You can define NI-DAQmx virtual channels outside a task (global) or inside a task (local). Configuring virtual channels is optional in Traditional NI-DAQ and earlier versions, but is integral to every measurement you take in NI-DAQmx. In Traditional NI-DAQ, you configure virtual channels in MAX. In NI-DAQmx, you can configure virtual channels in either MAX or in a program, and you can configure channels as part of a task or separately.

3. Switch—a switch channel represents any connection point on a switch. It may be made up of one or more signal wires (commonly one, two, or four), depending on the switch topology. A virtual channel cannot be created with a switch channel. Switch channels may be used only in the NI-DAQmx Switch functions and VIs.

chart — To append new data points to the end of an existing plot over time.

CodeBuilder — LabWindows/CVI feature that creates code based on a `.uir` file to connect your GUI to the rest of your program. This code can be compiled and run as soon as it is created.

coercion — Automatic conversion that Measurement Studio controls perform to change the numeric representation of a data element.

COM — Component Object Model. Microsoft specification for architecting and developing reusable software components.

complex graph	A control that displays `ComplexDouble` data on a Windows Forms user interface; the `ComplexDouble` data type represents a complex number of type `Double` that is composed of a real part and an imaginary part.
context-sensitive help	Help for dialog boxes, the controls in dialog boxes, and keywords in source code that you can access with the key or a Help button, or by clicking the link that appears in the Dynamic Help window in Visual Studio .NET.
control	1. ActiveX control. See ActiveX control. 2. Object for entering, displaying, or manipulating data on a user interface.
counter/timer I/O	Reading or writing data based on high-precision timing through a counter or timer. By combining a counter with a highly accurate clock, you can create a wide variety of timing and counting applications, such as monitoring and analyzing digital waveforms and generating complex square waves.
cursor	Flashing rectangle that shows where you may enter text on the screen. If you have a mouse installed, there is a rectangular mouse cursor, or pointer.
cursor label	Text object used to display X and Y coordinates that a cursor crosshair points to on a graph.

D

DAQ	Data acquisition. Process of acquiring data, typically from A/D or digital input plug-in boards.
DAQ Assistant	A graphical interface for configuring measurement tasks, channels, and scales.
DAQ device	A device that acquires or generates data and can contain multiple channels and conversion devices. DAQ devices include plug-in devices, PCMCIA cards, and DAQPad devices, which connect to a computer USB or 1394 (FireWire) port. SCXI modules are considered DAQ devices.
DataSocket	Technology that simplifies live data exchange between applications and HTTP, FTP, OPC, logos (Lookout objects) and file servers over the Internet. It provides one common API to a number of different communication protocols.

device	An instrument or controller you can access as a single entity that controls or monitors real-world I/O points. A device is often connected to a host computer through some type of communication network. *See also* DAQ device *and* measurement device.
digital I/O	Reading or writing digital representations of data in discrete units (the binary digits 1 and 0). Digital information is either on or off.
digital waveform graph	A control that displays Digital Waveform data on a Windows Forms user interface; the Digital Waveform data type represents a set of digital states that are grouped by samples or signals.
distribution	Ability to install programs you develop with Measurement Studio to others working on different computers.
DLL	Dynamic Link Library. A library of functions that link to a program and load at run time rather than being compiled into the program. Loading libraries only when they are needed saves memory in software applications.
DMM	Digital Multimeter. A common measurement instrument that measures resistance, current, and voltage in a wide variety of applications.
driver	Software that controls a specific hardware device, such as a data acquisition board or GPIB interface board. *See also* instrument driver.
DSTP	DataSocket Transfer Protocol. Protocol based on TCP/IP to exchange data directly between two applications using DataSocket clients. Data is passed through a DataSocket Server between the applications.

E

Ethernet	Standard connection type for networks, where computers are connected by coaxial or twisted-pair cable.
event	Object-generated response to some action or change in state, such as a mouse click or a completed acquisition. The event calls an event procedure that processes the event.
executable	Program file with a `.exe` extension that you can run independently of the development environment in which it was created.

F

form	Window or area on the screen on which you place controls and indicators to create the user interface for your program.
front panel	Interactive user interface of a virtual instrument. Modeled after the front panel of physical instruments, it is composed of switches, slides, meters, graphs, charts, gauges, LEDs, and other controls and indicators.
FTP	File Transfer Protocol. Protocol based on TCP/IP to exchange files between computers.

G

gauge	A control used to input or display numerical data.
GPIB	General Purpose Interface Bus. The standard bus used for controlling electronic instruments with a computer. Also called IEEE 488 bus because it is defined by ANSI/IEEE Standards 488-1978, 488.1-1987, and 488.2-1987.
graph	A 2D or 3D display of one or more plots.

H

HTTP	HyperText Transfer Protocol. Protocol based on TCP/IP, which is used to download Web pages from an HTTP server to a Web browser.

I

IEEE 488	Shortened notation for ANSI/IEEE Standards 488-1978, 488.1-1987, and 488.2-1987. *See also* GPIB.
IMAQ Vision	National Instruments image acquisition and analysis software that you can use to acquire images from National Instruments image acquisition (IMAQ) boards, display them in your program, perform interactive viewer operations, and analyze the images to extract information.
indicator	A control in read-only mode.

installer	Software program that copies program, system, and other necessary files to computers.
instrument driver	Library of functions to control and use one specific physical instrument. Also a set of functions that adds specific functionality to an application.
Instrument I/O Assistant	Assists in writing code to communicate with devices such as serial, Ethernet, or GPIB instruments. The Instrument I/O Assistant provides a user interface within the Visual Studio .NET environment. You use the Instrument I/O Assistant to interactively write commands to a device, read data that the device returns, and specify how to parse the response.
interface	Connection between one or more of the following: hardware, software, and the user. For example, hardware interfaces connect two other pieces of hardware.
IVI	Interchangeable Virtual Instruments. A technology involving standard programming interfaces for classes of instruments, such as oscilloscopes, DMMs, and function generators, that results in hardware-independent instrument drivers. The IVI standard programming interfaces have been defined by the IVI Foundation, an industry consortium. Refer to `www.ivifoundation.org` for more information.

K

knob	A control used to input or display numerical data.

L

LabVIEW	Laboratory Virtual Instrument Engineering Workbench. Graphical development environment used for developing test and measurement applications.
LabWindows/CVI	ANSI C development environment for building test and measurement applications.
LED	Light-Emitting Diode. An indicator that emits a light when current passes through it. For example, an LED shows if your computer or printer is turned on.
legend	A control that displays symbols and descriptions for a specific set of elements of another object, such as the plots or cursors of a graph.

M

matrix	A rectangular array of numbers or mathematical elements that represent the coefficients in a system of linear equations.
MB	Megabytes of memory.
Measurement & Automation Explorer (MAX)	National Instruments tool for configuring your National Instruments hardware and driver software; executing system diagnostics; adding new devices, interfaces, and virtual channels; and viewing devices and instruments connected to your system.
measurement device	DAQ devices such as the E Series multifunction I/O (MIO) devices, SCXI signal conditioning modules, and switch modules.
Measurement Studio	National Instruments software that includes tools to build measurement applications in Visual Basic .NET, Visual C#, and Visual C++ .NET.
meter	A control used to input or display numerical data.
method	Function that performs a specific action on or with an object. The operation of the method often depends on the values of the object properties.
MFC	Microsoft Foundation Class. A framework for programming in Microsoft Windows, MFC provides code for managing windows, menus, and dialog boxes; performing basic input/output; storing collections of data objects; and more.

N

NI-488.2	Driver-level software to control and communicate with National Instruments GPIB hardware.
NI-DAQ	Driver-level software to control and communicate with DAQ hardware. NI-DAQ is an extensive library of VIs and functions you can call from an application development environment (ADE) to program all the features of an NI measurement device, such as configuring, acquiring and generating data from, and sending data to the device.

NI-DAQmx	The latest NI-DAQ driver with new VIs, functions, and development tools for controlling measurement devices. The advantages of NI-DAQmx over earlier versions of NI-DAQ include the DAQ Assistant for configuring channels and measurement tasks for your device for use in LabVIEW, LabWindows/CVI, and Measurement Studio; increased performance such as faster single-point analog I/O; and a simpler API for creating DAQ applications using fewer functions and VIs than earlier versions of NI-DAQ.
NI-IMAQ	Driver-level software to control and communicate with National Instruments image acquisition hardware.
numeric edit	A control used to display and edit numeric values.

O

OCX	OLE Control eXtension. Another name for ActiveX controls, reflected by the `.ocx` file extension of ActiveX control files.
OLE	Object Linking and Embedding. *See* ActiveX.
OPC	OLE for Process Control. An industry standard based on ActiveX and COM technologies that enables you to create a single client application that can communicate with disparate devices. Refer to `www.opcfoundation.org` for more information.
oscilloscope	Measurement instrument widely used in high-speed testing applications, such as telecommunication physical layer testing, video testing, and high-speed digital design verification.

P

PCI	Peripheral Component Interconnect. High-performance expansion bus architecture commonly found in PCs.
PID	Proportional-Integral-Derivative. A three-term control mechanism combining proportional, integral, and derivative control. You might use a PID algorithm to control processes such as heating and cooling systems, fluid level monitoring, flow control, and pressure control.
plot	1. Trace (data line) on a graph representing the data in one row or column of an array. 2. To display a new set of data while deleting any previous data on the graph.

point	Structure that contains two 16-bit integers that represent horizontal and vertical coordinates.
property	Attribute that defines the appearance or state of an object. The property can be a specific value or another object with its own properties and methods. For example, a value property is the color (property) of a plot (object), while an object property is a specific Y axis (property) on a graph (object). The Y axis itself is another object with properties, such as minimum and maximum values.
property editor	A control used to configure properties for Windows Forms controls at run-time.
property pages	Window or dialog box that displays current configuration information and allows users to modify the configuration.
PXI	PCI eXtensions for Instrumentation. Rugged, open platform for modular instrumentation with specialized mechanical, electrical, and software features. Refer to `www.pxisa.org` for more information.

R

range	Region between the limits within which a quantity is measured, received, or transmitted. The range is expressed by stating the lower and upper range values.

S

scalar	Number that a point on a scale can represent. The number is a single value as opposed to an array.
scale	Part of graph, chart, and some numeric controls and indicators that contains a series of marks or points at known intervals to denote units of measure.
scatter graph	A control that displays two-dimensional data on a Windows Forms user interface; displays a graph of X and Y data pairs.
scope	*See* oscilloscope.
serial	Standard serial bus on a computer used to communicate with instruments. Also known as RS-232.
slide	A control used to input or display numerical data.

slider	Moveable part of a slide control.
switch	A control used to receive and control Boolean input in an application user interface.
synchronous	Property or operation that begins and returns control to the program only when the operation is complete.

T

tank	A control used to input or display numerical data.
task	NI-DAQmx—a set of channels and the channel configurations, timing, and triggering, and other details that define a measurement or generation you want to perform.
TCP/IP	Transmission Control Protocol/Internet Protocol. A standard format for transferring data in packets from one computer to another. The two parts of TCP/IP are TCP, which deals with the construction of data pockets, and IP, which routes them from computer to computer.
TestStand	Ready-to-run test executive from National Instruments for organizing, controlling, and executing your automated prototype, validation, or manufacturing test systems.
thermometer	A control used to input or display numerical data.

U

UI	User Interface.

V

vector	1D array.
virtual instrument (VI)	Program in Measurement Studio that models the appearance and function of a physical instrument.

VISA	Driver-software architecture developed by National Instruments to unify instrumentation software for serial, GPIB, and VXI instruments or controllers. It has been accepted as a standard for VXI by the VXI *plug&play* Systems Alliance.
VXI	VME eXtension for Instrumentation. Instrumentation architecture and bus based on the VME standard. Used in high-end test applications.

W

waveform graph	A control that displays two-dimensional data on a Windows Forms user interface; displays data that is uniformly spaced in one dimension.

Index

A

ActiveX controls in Visual C++, 3-2
Add/Remove Class Libraries wizard, 4-4
adding or removing Measurement Studio class libraries, 4-4
Analysis
  .NET class library, 2-2
    Array and Numeric Operations (table), 2-9
    Curve Fitting (table), 2-9
    Enterprise Analysis, 2-3
    Filters (table), 2-5
    Linear Algebra (table), 2-6
    Measurements (table), 2-3
    Professional Analysis, 2-2
    Signal Generation (table), 2-4
    Signal Processing (table), 2-5
    Standard Analysis, 2-2
    Statistics (table), 2-10
    Windowing (table), 2-4
  Visual C++ class library, 3-3
    Array and Numeric Operations (table), 3-10
    Curve Fitting (table), 3-11
    Enterprise Analysis, 3-4
    Filters (table), 3-6
    Linear Algebra (table), 3-8
    Measurements (table), 3-5
    Professional Analysis, 3-4
    Signal Generation (table), 3-5
    Signal Processing (table), 3-7
    Standard Analysis, 3-4
    Statistics (table), 3-11
    Windowing (table), 3-6

B

button control, 3-20

C

calling Instrument Drivers from .NET languages, 4-38
class driver class libraries
  IviDcPwr, 3-15
  IviDmm, 3-15
  IviFgen, 3-15
  IviScope, 3-16
  IviSwitch, 3-16
Common
  .NET class library, 2-12
  Visual C++ class library, 3-14
complex graph control, 2-20
conventions used in the manual, *x*
creating
  Measurement Studio Application with Windows Forms Controls and Analysis (walkthrough), 4-5
  Measurement Studio Instrument I/O Application (walkthrough), 4-30
  Measurement Studio NI-488.2 or NI-VISA application, 4-28
  Measurement Studio NI-DAQmx application, 4-13
  Measurement Studio NI-DAQmx Application (walkthrough), 4-15
  new Measurement Studio project, 4-3
  NI-DAQmx user control, 4-15

D

DAQ Assistant, 4-13
data acquisition (DAQ), 2-14, 3-17
DataSocket
    .NET class library, 2-13
    Visual C++ class library, 3-15
deployment requirements, 1-2
developing with Measurement Studio, 4-1
digital waveform graph control, 2-18
documentation
    conventions used in the manual, *x*
    how to use manual set, *ix*

G

gauge control, 2-22
graph control
    3D, 3-2
    ActiveX, 3-21
    complex, 2-20
    digital waveform, 2-18
    scatter, 2-16
    waveform, 2-16

H

help
    NI Measurement Studio Help, 1-6
how to use manual set, *ix*

I

installation
    optional, 1-2
    procedure, 1-2
    requirements, 1-1
instrument driver wizard, .NET, 4-38
Instrument Drivers Visual C++ class library, 3-15
Instrument I/O Assistant, 4-28

K

knob
    .NET control, 2-22
    Visual C++ control, 3-22

L

LabVIEW Real-Time Interface Visual C++ class library, 3-16
LED control, 2-25
legend control, 2-21

M

Measurement & Automation Explorer (MAX), 4-2
Measurement Studio
    developing with, 4-1
    home page, 4-3
    Menu, 4-2
    overview, 1-1
    package comparison chart, 1-4
    Preferences, 4-3
    resources, 1-6
meter control, 2-23
Microsoft Excel Interface Visual C++ class library, 3-16
Microsoft Word Interface Visual C++ class library, 3-17

N

.NET class libraries
    Analysis, 2-2
    Common, 2-12
    NI-488.2, 2-13
    NI-DAQmx, 2-14
    NI-VISA, 2-15
    overview, 2-1
    User Interface, 2-15
    deployment requirements, 1-2

NI DAQ Assistant, 4-13
NI Discussion Forums, 4-2
NI Instrument Driver Network, 4-2
NI Measurement Encyclopedia, 4-3
NI Spy, 4-2
NI-488.2
creating a 488.2 application, 4-28
.NET class library, 2-13
Visual C++ class library, 3-17
NI-DAQmx
creating a DAQ application, 4-13
.NET class library, 2-14
Visual C++ class library, 3-17
NI-Reports Visual C++ class library, 3-18
NI-VISA
creating a VISA application, 4-28
.NET class library, 2-15
Visual C++ class library, 3-18
numeric controls, 2-22
numeric edit
.NET control, 2-24
Visual C++ control, 3-23

O

overview
Measurement Studio, 1-1
.NET class libraries, 2-1
Visual C++ class libraries, 3-1

P

Parameter Assistant, 4-38
project conversion wizard, 4-2
project templates, 4-3
property editor control, 2-26

R

requirements
distribution, 1-2
installation, 1-1

S

scatter graph control, 2-16
selecting a Measurement Studio parameter value, 4-38
slide control
.NET, 2-23
Visual C++, 3-24
switch control, 2-25

T

tank control, 2-23
thermometer control, 2-23

U

User Interface
.NET class library, 2-15
complex graph, 2-20
digital waveform graph, 2-18
gauge, 2-22
knob, 2-22
LED, 2-25
legend, 2-21
meter, 2-22
numeric edit, 2-24
property editor, 2-26
scatter graph, 2-16
slide, 2-23
switch, 2-25
tank, 2-23
thermometer, 2-23
waveform graph, 2-16

Visual C++ class library, 3-19
button, 3-19
graph, 3-21
knob, 3-22
numeric edit, 3-23
slide, 3-24
Utility Visual C++ class library
CNiFile (table), 3-25
CNiSound (table), 3-25
CNiSystem (table), 3-25
CNiSystemTrayIcon (table), 3-25
CNiTempFile (table), 3-26
CNiTimer (table), 3-26

V

Visual C++ class libraries
3D graph, 3-2
Analysis, 3-3
Common, 3-14
deployment requirements, 1-2
Instrument Drivers, 3-15
LabVIEW Real-Time Interface, 3-16
Microsoft Excel Interface, 3-16
Microsoft Word Interface, 3-17
NI-488.2, 3-17
NI-DAQmx, 3-17
NI-Reports, 3-18
NI-VISA, 3-18
overview, 3-1
User Interface, 3-19
Utility, 3-25

W

walkthrough
Creating a Measurement Studio Application with Windows Forms Controls and Analysis, 4-5
Creating a Measurement Studio Instrument I/O Application, 4-30
Creating a Measurement Studio NI-DAQmx Application, 4-15
waveform graph control, 2-16
Windows Forms user interface controls, 2-15